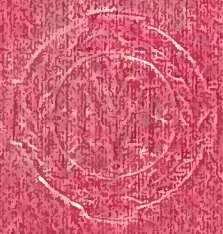

GROWTH OF THE RECRUIT

AND

YOUNG SOLDIER

ON THE

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AND

YOUNG SOLDIER

WITH A VIEW TO

A JUDICIOUS SELECTION OF 'GROWING LADS' FOR THE ARMY, AND A REGULATED SYSTEM OF TRAINING FOR RECRUITS

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SECOND EDITION

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"The foreground of human life is the only part of it which we can examine with real exactness."—FROUDE'S *Short Essays on Great Subjects.*

"If we are to devote our attention, before all things, to what can be measured and weighed, the living man is the first object which demands our investigation."—CARL VOGT.

"By long and varied experience we judge the interiors by the outsides, and so acquire a physiognomical intuitive knowledge of them."—SIR THOMAS BROWNE.

"Science is measurement."—S. MARKS, R.A.

PREFACE TO THE SECOND EDITION

It is twenty-five years since the First Edition of this book was published, under the circumstances stated in its Preface, herewith reproduced; and having been frequently requested to issue another Edition, I do so in the hope that, as the First Edition was deemed of use in its day, this one may still more fully meet the requirements of the time; for the circumstances which justified the first publication are far more pronounced now than they were twenty-five years ago.

The subject-matter has been recast, and the book rewritten. This has increased its size, mainly on account of the increased information regarding the topics discussed, and their increasing importance.

The lecture-form has been retained, but the material, for convenience of reference, has been arranged in sections.

Great changes have taken place during the past twenty-five years in the organisation of the Army, and especially in its Medical Department.

An estimate of the quality, strength, and capacity of human material should be primary to the formation

of any army. The military medical officer, from the nature of his education and studies, ought to be better acquainted with the nature of the material of which armies are composed than men of any other profession ; and, in order that none but able-bodied men should be put in the field, a thorough and systematic examination of them is necessary. For it has been fully demonstrated that the placing of "growing lads" in the field, who are physically immature, has not only been poor economy, but has sometimes been fatal to the success of military operations. Such lads have always been found disqualified and unable to perform the duties or to endure the hardships incident to the life of a soldier.

"Nothing is so expensive as an unhealthy military force;"[1] and "an army raised without due regard to the choice of recruits was never yet made a good army by any length of service."[2]

The changes in the organisation of the Army and its Medical Staff during the past ten years have greatly increased the duties and responsibilities of the military medical officer, especially as to the selection of "growing lads" and young men for the services; and also in maintaining them in health and efficiency : (1) as recruits under training ; and (2) as soldiers in the ranks. The duties and responsibilities of medical men in civil life who undertake the duty of examining recruits have also proportionately increased.

[1] Dr. William Farr.

[2] Vegetius Renatus, *De re Militari*, vol. i. cap. 7.

Moreover, the requirements of the Army Medical Service demand that the examining medical officer of recruits and soldiers should possess not only a high order of professional talent, but that he should combine with it a knowledge of human nature, and be possessed and inspired in his work by the "*animus mensurandi*" of Sir J. F. W. Herschel, so that *without bias* he may fairly judge as to the physical and mental capacity of men under the most varied circumstances.

In all ages and in all military nations the limitations as to height and age in a recruit have varied with the demand for men, and to help in estimating age is one of the objects aimed at in this volume.

The changes in the Organisation of the Army which mainly concern us here are those which are due to the "Principle of Localisation," from which it is hoped that regiments will become more or less identified with the locality from which their recruits are mainly drawn. Such a change is believed by many to be an advantage from a recruiting point of view; and as it is hoped that the recruits enlisted will do credit to the country or district to which they belong, so also it is hoped that the parents of men wishing to enter the army may be induced to encourage their sons to enlist, instead of throwing obstacles in the way of their enlistment. The advantages which the army offers as a career to all classes of the community compare favourably with those of thousands of clerks and shopmen who

spend a lifetime at a desk or counter on wages that yield but a bare subsistence.

The changes which have thus been made in localisation and organisation of the army, in the administration and development of the recruiting districts, in the freer, fuller, and more honest advertisement of the wants of the service, have all contributed largely to the popularity and knowledge of the army among the people at large.

But it is still necessary that a knowledge of what is wanted as to *physique* should be spread amongst the civil population; and hence another object aimed at in this book is to arrive at sound conclusions as to the principles on which a *minimum* standard as to height, weight, and chest-girth may be safely fixed upon, so that no eligible lad need be refused enlistment who is likely to become an efficient soldier.

The numbers of recruits to be got will always be greatly influenced by increased or decreased employment in civil life—by the depression or activity of trade and commerce. When trade and commerce are in a state of depression, the means of subsistence to many are limited and even precarious, so that many lads and young men seek to enter the army in such times. Then it is that, with increased numbers seeking military life, we are apt to get inferior quality as to the physique of the recruit, especially under the influence of scarcity of food, which again influences the predisposition to disease.

Different opinions still exist as to the proper age for enlistment; and the published standards as to the physical requirements of recruits, especially as to height and girth of chest in relation to age, point to the necessity of a better knowledge of the development and physical proportions of "growing lads" and young men in relation to age. It is only from such better knowledge that safe physical standards can be arrived at, and fixed, especially as to average heights, girths, and weights, with the range of their *maxima* and *minima*, for the safe guidance not only of the medical officers, but also of the military authorities themselves. It is also an inevitable result that as quality improves quantity decreases.[1]

As to the changes in the organisation of the Medical Staff of the Army, they are not only such as enlarge its sphere of duty, but greatly increase the responsibility of the army medical officer. He is no longer the servant of any special regiment, but is entirely at the disposal of the Director-General. The past fifteen years have therefore been years of activity and progress. The staff has been increased in number, and the Army Medical Regulations have been revised and republished.

Regulations for the medical examination of recruits and re-engaged men are issued from time to time by the military authorities; and these have cast a greater amount of work and responsibility upon the medical officer: *firstly*, because of the very

[1] *Report by the Inspector-General of Recruiting*, of date January 1, 1876.

great (and annually increasing) number of volunteers for military service—more than double the number of those finally accepted—who have each to be individually examined ; and *secondly*, because of the special knowledge of the physiognomy of disease and the rapid application of this knowledge to the work of inspection, so as to prevent the unfit from being accepted as recruits ; and *thirdly*, because the medical officer has to select, individually, the "growing lad" as a recruit in accordance with healthy physiological requirements, having due regard to his age (which he must determine for himself) in relation to the more or less complete development, the normal growth, the general healthiness and fitness of the individual for military duties.[1]

For such important and responsible duties a knowledge of the structure of the animal body and of the laws which regulate its economy is an indispensable requisite, not only for those who have to select the material of armies, but for those who have to superintend the training of recruits. Such knowledge is only to be gained "by scientific methods, and by the help of a thoroughly scientific organisation of such methods,"—by a technical education, in fact, in respect to the material they have to deal with, and the requirements or work that is to be exacted from it. The intelligence of the drill-sergeant ought to be trained to the highest point to

[1] *Queen's Regulations and Orders for the Army*, 1885, and *Regulations for the Army Medical Department of Her Majesty's Army*, 1885, and Appendix at end of volume for details.

which he can attain—higher than it is at present. He ought to be instructed in human anatomy, and be made acquainted with the more elementary facts of physiology, so that he may, at least, know how an animal body works, and what a human body is capable of enduring before it fails in its action. From such knowledge he may be taught to calculate what man may do; and he may learn from history what man has actually done; and, also, the circumstances under which he has failed in the accomplishment of his designs.

If such desirable ends are to be attained, it is obvious that longer time ought to be given than heretofore, not only to the details to be observed and studied regarding the examination of recruits for selection, but also to the training of them; and to the instructions of the surgeons on probation, and junior medical officers, in these very important duties.

WILLIAM AITKEN.

Army Medical School,
Netley Hospital, *Sept.* 1887.

*** I am indebted to Sir William Turner, Professor of Anatomy in the University of Edinburgh, for permission to use the illustration of the axial skeleton at p. 78; and to Dr. Donald MacAlister and the Messrs. Macmillan for permission to use the five woodcuts from a paper on "How a bone is built," published in the June Number of *The English Illustrated Magazine* for 1884; also to Messrs. Charles Griffin and Co. for the two illustrations of the Jaws and Teeth.

My special thanks are especially due to my friend, Deputy Surgeon-General Dr. Henry L. Veale, for his kindness in reading the proofs, and for very valuable suggestions as the pages passed through the press.

PREFACE TO THE FIRST EDITION

THE following pages embrace the topics of two lectures, introductory to the practical Courses of Instruction at the Army Medical School, delivered at the opening of its Fourth Session, in April 1862.

Divested of technical terms in its treatment, the subject was believed to be of sufficient importance to warrant publication in a form that might be useful and suggestive to those who have to do with recruits and young soldiers; and at the request of Major-General Eyre, commanding the garrison at Chatham, it is now published, amplified to some extent in detail, but retaining the form in which, as Lectures, the topics were originally put together.

Those who have to do practically with the recruit in teaching him military duties and drill, and in pressing him forward to fill up voids in the ranks within as short a time as possible, do not sufficiently regard the physiological constitution of the "growing lad," nor the nature of his skeleton framework as the material they have to deal with in training him.

The principles (physiological?) which have hitherto guided the military authorities in the selection of recruits appear to be unsound: (1) as regards

the correlation of age and height; and (2) as taking no cognisance of weight, development, bulk, or growth, in their relations to age and height. The result is, that teaching the recruit his military duties and drill, and taxing him prematurely with the routine duties of the soldier's life, eventually lead to the discharge of a proportionally large number of young soldiers before they have been three years or even two years in the service; and the greater portion even of these two or three years is spent in hospital. Any part of an army composed of such material can never constitute a very formidable phalanx; and the service of such soldiers represents merely a nominal strength.

The result of such injudicious selection of "growing lads," and still more so, the ill-regulated exercise of them, in place of their being systematically trained, tends to encumber the military hospitals in the first instance; and if military duties and drill do not lead directly to the premature death of the young soldier, they sooner or later lead to his being discharged from the army as unfit for a soldier's duty. Thus he is thrown out of the service and becomes a burden upon the civil population, with one or more of his vital organs damaged for the remainder of his life.

For the military service of Great Britain the recruit is a volunteer. He chooses to be a soldier. He selects of his own free will an employment in which he may thus break down at an early period in

the hands of the drill-sergeant, who, with the best intentions, tries to make him a soldier, sometimes within sixty days, when he is considered fit to endure the fatigue and the labour of active military service at home or abroad—a service in which he may be led to suffer the pains of wounds, to toss on a fever-bed in the camp-tent or the hospital ward, or even to die on the battlefield.

In accepting services thus so freely offered, it is surely alike the duty and the interest of the nation to place the recruit under such conditions as are the best possible for rendering his life fully available and profitable to his country.

Considered merely in a money point of view (if, as calculated, a soldier costs the country £100 a year), it is worth some care and trouble to train him efficiently and economically, which can only be done by keeping him in good health and condition during the period of training, and conducting such training according to a well-regulated system, based on the established truths of physiology.

Apart, therefore, from motives of humanity—generally the first to arouse sympathy and to initiate action—the main object of the following pages is to demonstrate the "growth of the recruit and the young soldier," with a view to suggest a judicious selection of "growing lads" for the army, and a regulated system of training recruits. It must be admitted that the subject is one which immediately concerns the health, the wealth, and the military strength of a

nation; and I would claim, at least for the recruit, the exercise of a judgment in selecting him not less sound, and of a care in training him not less scientific, than the judgment and the care which a gentleman thinks judicious and proper to bestow upon a useful dog or a valuable horse.

FORT PITT,
CHATHAM, *July* 1862.

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SECTION I

INTRODUCTORY

GENTLEMEN—It is my duty in this place—the General Lecture Room of the Army Medical School—to bring to your notice certain topics in Pathology, especially such as relate to those prevailing antecedent conditions or factors which combine to produce diseases, or which tend to impair the health of soldiers, and therefore the efficiency of Armies.

In the *post-mortem* room and Pathological Laboratory, we have to examine into the morbid anatomy of the soldier, by a study of the tissue changes in his body which have been effected by disease. In so doing, we have to examine such special questions as pertain to Pathological Anatomy. We must look at diseases not as mere entities, but as physiological processes during life running an abnormal course; and we still rely on anatomical methods as sufficient to elucidate many of the problems of such abnormal life; for it is certain that anatomical and biochemical changes

lie at the bottom of the morbid phenomena, while, for the most part, such changes are still recognisable after death as "stamps," which indicate the previous existence of disease.[1]

It is therefore our duty to investigate with all possible exactness and detail the tissue changes which are involved in the various forms of disease. We may not always be able to recognise the evidence of disease from tissue change alone, because the change may not be of gross structure but of chemical constitution, in which the Ptomaïnes, the Leucomaïnes, and the Extractives form important subjects of study and inquiry.[2]

The appropriate objects for our investigation consist, in the first instance, "of morbidly altered tissues taken from the human subject, after which there will remain many questions, for whose complete answer one must needs have recourse to experiments on animals."[3]

In such pursuits the use of the microscope is absolutely necessary, and, as a fact, it has in countless cases thrown an utterly unexpected light upon those processes; while the enormous advance of pathological anatomy in the last quarter of a century or so has been brought about simply by the exact attention bestowed upon them. VIRCHOW it was who established this new method on a firm basis.

[1] Consult Ziegler's *General Pathological Anatomy*, by Donald Macalister, M.A., M.B. (Macmillan & Co., 1886-87).

[2] Dr. Aitken, *Animal Alkaloids, The Ptomaïne*, etc. (Lewis, 1887).

[3] Ziegler, *l. c.*, p. 11.

Microscopic examination of cellular and intercellular changes, in connection with naked-eye *post-mortem* examinations, still remains the foundation on which our knowledge of disease and its nature must be based.

A knowledge of the morphology, the genesis, and the ætiology of morbid changes is thus the aim and object of pathological anatomy; and our method must be by *post-mortem* examinations, direct or macroscopic, on the one hand; by microscopic examination, and experiment, on the other.[1]

These topics in pathology and such practical work in morbid anatomy have been prescribed for our consideration by the Secretary of State for War.

As regards our special studies, we are limited to certain "phases of life"—those varying phases which pertain to "the military age," and to military as distinguished from civil life. That is to say, we have to deal with ages from 16 up to 45 or 50, but mainly from 18 to 45; and we have to deal with youths and men, rather than with women and children. Incidentally, however, you may have to care for the wives and families both of officers and men.

The "phases of life" in the rank and file of the army at home and abroad present many and varied aspects for special study; and many questions will present themselves for your consideration in the future, relative to the sanitary conditions in which soldiers live, and to the prevalence of disease amongst them—questions which must be looked at from many

[1] Ziegler, *l. c.*, p. 9.

points of view, and on which you will receive special instruction.

The topics which I have to consider with you relate to the pathology of those diseases most frequently met with in military as contrasted with civil life.

The sphere of your professional work seems thus far to be circumscribed within narrower and more definite limits than is the work of your civilian brother; but, on the other hand, you have many more details to take official notice of and to record in your daily routine work than are required of him. Moreover, he incurs none of the risks incidental to military life; while you, in time of war and in campaigns, are as much exposed to the chances of wounds, injuries, and death as any combatant officer; while in war and in peace alike you are much more exposed to the incidence of disease than combatant officers are.

In the general practice of the civilian medical man all ages of humanity are embraced and all phases of life in all classes and conditions of men, women, and children. They furnish the "materials" with which your civilian brother has to deal singly or in families.

The "material" with which the army medical officer has to deal first challenges our attention. It consists of the non-commissioned officers, youths, and men who constitute the rank and file of the army; and we must first "take stock of them" as

we find them, doing duty in all parts of Her Majesty's empire.

You are, in fact, required to look upon the British army at home and abroad as one vast family, of which the non-commissioned officers and men are the children cared for by their officers, who ought to stand to them *in loco parentis;* and the following pages are mainly concerned with questions in pathology as bearing upon the non-commissioned officers and men.

One of the first things a general practitioner in civil life—the family doctor, as he is commonly called—desires to know of a family concerns their ages, their occupations, and the general surroundings under which they live and work. "Age," I need scarcely remind you, is an element or factor of prime importance, not only to be reckoned with in relation to the incidence of disease and death, but to be taken into consideration from many points of view in pathology, more especially as predisposing to certain ailments at certain ages rather than to others, and as markedly influencing mortality. The two factors—sickness and mortality—are most important items in military medical statistics requiring constant watching to prevent their increase.

Speaking generally, the investigations which mainly underlie your practical work and duties in the future relate especially to the causation of diseases, with a view to their prevention; and in such investigation the time has come when new lines

of thought and of departure in pathology require to be opened up, which may lead us to entertain broader, or, at any rate, less narrow views as to the origin of diseases.

In the first place, it seems desirable to get rid of the term "cause" altogether, as applied to any particular disease. Our text-books as yet have not been able to specify any single thing as the final cause of any disease. There is no disease we know of which acknowledges any single cause, even in the shape of a "*microbe*" or "*bacterium*," however minute.

It ought therefore to be our business to find out the many and ever-varying factors or antecedent conditions which combine to produce disease; and while we must acknowledge the influence of certain physical agents in aiding and abetting these factors and conditions, we must mainly look to the physiological agency of our own bodies during life in bringing about diseases.

The undue prevalence, therefore, of any disease amongst bodies of men will demand the most careful investigation in the routine of your daily duty, to find out the antecedent conditions and factors which combine to produce the disease.

It is (1) the undue prevalence of certain ailments and the predisposition to some rather than to others amongst soldiers; and (2) the mortality, which contribute with the invaliding to reduce the strength of armies.

Having these considerations in view, the earliest condition in which we come into professional relationship with the soldier is that in which we see him as a recruit. His physical condition is then of prime moment as part of the material composing the army.

The life of a man or woman—soldier or civilian—is divisible into certain periods which successively merge one into another, and which, in the main, are characterised by distinct and recognisable structural conditions and functional manifestations both of health and of disease.[1] These periods are three in number :—

(1) The period of development or evolution of his body and of its several organs.

(2) The period of maturity.

(3) The period of decline, degeneration, devolution, or, as it has been also conveniently termed, the period of "involution."

The first period, *that of development*, extends from the impregnation of the ovum to the complete growth of the body and the differentiation of its component tissues and organs. It comprises the stages: (1) of *fœtal life;* (2) of *infancy*, from birth to the time of first dentition; (3) *childhood*, from the appearance of the milk teeth to the cutting of the first of the permanent set, *i.e.* from the end of the 1st year to the 7th year; (4) *boyhood* or *girlhood*, which extends from this time up to *puberty* at 14th

[1] Alchin, *Medical Times and Gazette*, vol. ii., 1885.

or 15th year; (5) *adolescence*, which denotes the period of "growing up" from puberty to complete development of the body and of all its parts in the adult at about the 23d to 25th year of life, when the individual has reached maturity.

The *duration of maturity* is a variable period; but in connection with the influence of age on the incidence of disease we may consider the period of maturity as lasting from the 25th to the 55th year. After 55 the period of decline may be considered to begin. This period—"*the period of decline*"—is rarely separated by any sharply-distinguishing feature from that which has preceded it; but, slowly and gradually, the individual fails in power, slowly deteriorating from year to year until senility is fully established at the age, say, of the 75th to the 80th year.

Each of these three age periods suggests important distinctions as regards the health-power and life-power of the individual, and the varying liability they offer for the incidence of disease and for the course of disease when once established.

The main age periods are thus based on special physiological characteristics of the body rather than on any arbitrary divisions into months or years. But years and months "*mark time*," and its advance may be so anticipated or postponed as to give us instances of premature decay and death even at early manhood, or delay in development at the growing periods of life.

Hence the question of *age* is of prime significance and importance in respect of its influence upon diseases.

Successive periods of life are marked by certain characteristics, and as the diseases of each period have their distinctive features, we must be in possession of all the details of this knowledge in order to appreciate the significance of the influence of age upon disease. Possessed of such information, we approach all questions in pathology better able to investigate them in relation to each individual, and better able to appreciate the dangers of diseases and the chances of recovery from them.

Moreover, a knowledge of age and of the liabilities it entails suggests many directions in which to prosecute inquiries as to the many and varying factors which combine to produce disease, and as to the condition of the organs which may be at fault, or which may be perniciously influenced by agencies acting upon them especially during adolescence.

That age itself (with all that it may be said to imply as regards environment) exerts a most marked influence both in causing disease and determining mortality in civil life has been made obvious by the records of the Registrar-General.

The following Table I., extracted from the 46th Report of the Registrar-General for 1883, is given in illustration :—

TABLE I.—DEATH-RATES OF MALES AND FEMALES PER 1000 LIVING AT 12 AGE PERIODS[1] FROM 1881-1883, COMPARED TO AVERAGE OF 1838-1883.[2]

YEARS.	MALES.		FEMALES.	
	1881-83.	1838-83.	1881-83.	1838-83.
0 — . .	59.4	70.8	50.4	60.9
5 — . .	6.1	8.1	5.8	7.8
10 — . .	3.2	4.5	3.3	4.7
15 — . .	4.6	6.3	4.8	6.8
20 — . .	6.1	8.5	6.0	8.0
25 — . .	8.3	9.6	8.0	9.6
35 — . .	12.9	13.1	11.0	12.2
45 — . .	19.4	18.9	15.2	15.6
55 — . .	34.0	32.8	28.0	28.0
65 — . .	68.0	67.5	58.7	59.8
75 — . .	143.9	147.8	128.4	134.5
85 and above .	292.8	313.9	266.4	288.8
All Ages . .	20.5	23.0	18.3	21.0

It is from such statistics of civil life that we obtain standards for comparison for our purposes. In the Report by the Registrar-General for 1883 of the death-rate from all causes at 12 successive age periods, it is shown (1) how considerably the death-rate varies with age; (2) that the period of life at which fewest deaths occur is between 10 and 15 years.

It shows that the rate slowly falls from birth to that *minimum*, and subsequently rises, at first

[1] These "age periods" are completed portions of time of 5 years each, and the table is read thus: 0 — embraces all *under* 5 years; 5 — all between 5 and under 10 years, and so on. Consult *Vital Statistics*, by Dr. William Farr, a memorial volume, 1885, p. 207.

[2] Alchin, *Medical Times and Gazette*, vol. ii. p. 631, 1885.

gradually, but afterwards more rapidly to the end of life.

By comparing also the average rate for the three years 1881, 1882, and 1883 with the average for the forty-five years previously (1838-1883) the improvement in the death-rate, *i.e.* the diminished mortality which has taken place in males at all ages, except from 45 to 75, and in females at all ages, is evident and remarkable.

"The average of life, however, mainly depends on locality or environment, on hygienic precautions, and on the state of civilisation. But individual longevity may be exempt to some extent from these conditions, inasmuch as there is much evidence to show that individual long life is the result of an internal principle of vitality which privileged individuals receive or inherit at birth. This greater share of vital energy is so deeply impressed on the constitution or nature of such individuals as to make itself apparent in every part of their organisation."[1]

Advanced age generally expresses the transmission of "an inborn inherent quality of endurance, of steady, persistent, nutritive and reparative force, resistance to disturbing agencies, and a good proportion or balance between the several organs."[2]

[1] *Traité physiologique et philosophique de l'Hérédité naturelle* (P. Lucas, 1847).

[2] *On old age and the changes incidental to it*, by Professor G. M. Humphrey, London, 1885.

Besides liability to death at about the same ages prevalent in families, there is a similar liability to attacks of sickness, and to a certain extent we find that the influence of age upon sickness may be expressed in figures, although not with the same accuracy as the "death-rate" is formulated. The following Table II.[1] indicates the amount or duration of sickness that may be expected at different ages from 20 to 70 for males of the working classes—such sickness as incapacitates for work :—

TABLE II.—ANNUAL EXPECTATION OF SICKNESS FROM 20 TO 70 YEARS OF AGE.

At	20	years	expect	4	days'	sickness	yearly.
,,	20 to 30	,,	,,	5 or 6	,,	,,	,,
,,	45	,,	,,	7	,,	,,	,,
,,	50	,,	,,	9 or 10	,,	,,	,,
,,	55	,,	,,	12 or 13	,,	,,	,,
,,	60	,,	,,	16	,,	,,	,,
,,	65	,,	,,	31	,,	,,	,,
,,	70	,,	,,	74	,,	,,	,,

Similar results were obtained by Mr. Sutton from the investigation of the members of the Manchester Unity of Oddfellows.[2]

Generally it has been found that the probability of becoming sick is at a *minimum* about the 7th or 8th year, and from this *minimum* it increases to the

[1] *Annales d'Hygiène publique.*—Villermé, 1829.

[2] *Address on the National Value of Public Health*, June 17, 1884, by Sir James Paget.

18th year, when it again slowly falls till 24th to 30th year, from which time the liability increases to the end of life.[1]

Inasmuch, then, as each age is accompanied by a definite duration or amount of sickness, as well as by a specific death-rate, it becomes necessary to ascertain as far as possible the conditions which regulate this coincidence.

While the organism is growing and developing during adolescence, the great bulk of disease at this early period of life is determined either (1) by immediate or exciting causes which are largely under the individual's own control; or (2) under the control of those who have him in charge, or whose duty it is to care for him; or (3) by accidents which his occupation and surroundings expose him to, but which are, at the same time, largely preventible. The tables show how small a liability to sickness and death, comparatively speaking, prevails at the ages of development and growth, *i.e.* from 5 to 20 years inclusive.

The greater liability to phthisis in the young is a well-established fact. The liability of acute rheumatism to increase with age from 16 to 25, *i.e.* immediately preceding the establishment of complete maturity; while its *regularity* of increment is no less remarkable up to 35 years of age—an age which "covers the highest flood and ebb in the tide of life—a period during which man, in attaining the acme

[1] Alchin, *l. c.*

of his virility, most successfully resists the attacks or inroads of disease."[1]

These facts require to be kept in view in estimating the frequency or prevalence of those diseases in military as compared with civil life at those ages at which the diseases are *normally* most frequent. Typhoid or enteric fever, for example, is most frequent during adolescence and the first decade of adult life[2] (Broadbent, Murchison, and others).

"The number of injuries and diseases which occur in man is much greater than in any of the lower animals. The conditions of the welfare of the latter are strictly limited to the cosmical arrangements of their special areas of distribution, while their instinctive endowments determine precisely the amount of disturbance of health, or the amount of death, which occasional or periodical cosmical changes produce. So also injury and loss of life are necessary conditions of the general organic economy. For the life of a carnivorous animal involves the death of the animal on which it feeds, as the life of the herbivorous animal involves the death of the vegetable. Domestic animals are liable to numerous diseases and injuries; but these are due to their association with man, who entails upon them much suffering from which they would be saved if left to the guidance of their own instincts.

[1] Baxter's *Medical Statistics of the Provost-Marshal-General's Bureau*, vol. i. p. 73.

[2] Aitken's *Science and Practice of Medicine*, vol. i. p. 587, 7th edition.

As disease, then, is the result of a divergence from the conditions of health—a phase of life which deviates in some way from the normal type—and as man is privileged (in virtue of his conscious intelligence) to provide for himself the conditions of health over the extended area of the globe, and under a never-ceasing variation of circumstances, he is at the same time liable (also from the nature of his conscious intelligence) to diverge from those principles of truth which guide to the knowledge of the conditions of health, and to neglect that sense of duty which indicates the proper application of that knowledge when acquired, he becomes subjected to the necessary evil consequences. These involve all the disease and suffering which result from the neglect or infringement of duty to ourselves and to our fellow-men. They stand related to all the questions of personal and social ethics, and all the demands of public hygiene. Finally, these constitute the grounds of a general principle in the philosophy of medicine, which is "*that the greater liability of man to disease is intimately related to his higher conscious intelligence*"[1] and to his personal knowledge. But the relation is an inverse one. Hence ignorance is at the root of much disease alike in civil and in military life; and in civil life that kind of ignorance is often greatest where it ought not to be so—namely, amongst those who are otherwise well educated, and living in the best society and in the best of houses, but the sani-

[1] *Anatomical Memoirs of John Goodsir*, vol. i. pp. 329, 330.

tary arrangements of which are inefficient. It is therefore essential that we should possess a clear and comprehensive conception of all the arrangements by which human life is conditioned and modified—an extended series of facts, intimately and immediately connected with the wellbeing of humanity.[1]

These remarks especially apply to the selection, management, and training of recruits for the army, with reference to the incidence of disease in relation to their ages and the kind of work they have to do, to the knowledge (or want of knowledge), as regards human anatomy and physiology, possessed by those whose duty it is to drill and train them, or who have to devise and order their daily work and duties.

The youthfulness of our army now more than ever requires a rare combination of qualities in all commanding officers, in order to maintain its material in health and efficiency.

In addition to high professional acquirements, a knowledge of the world and of human nature as well as of what the human body can endure, the faculty of applying that knowledge with judgment and discretion in the training of boys and men, is essential to those who occupy such commands.[2] Not less efficient professional knowledge, technical skill, and qualifications are required of the army medical officer in the selection of the recruit.

[1] "A sustained rate of mortality above 17 in 1000 always implies unfavourable sanitary conditions."—Farr, *l. c.*, pp. 121, 148.

[2] *The Times*, January 7, 1887.

If we look to the loss of strength in the army, as represented by the number of invalids passing through Netley Hospital in any one year, or discharged the service elsewhere, it will be seen that a very large number are recruits under *one*, *two*, or *three* years' service, and that the greater proportion of their military existence has been spent in hospital. The *diseases* for which such young men are discharged the service are chiefly: (1) pulmonary disease; (2) heart disease; (3) epilepsy and disease of the nervous system; and (4) diseases of the bones and joints. It is also on record that a large percentage of those invalided for tubercular disease had not served three years; and a still larger percentage of those invalided for heart disease and diseases of the circulatory organs, and a larger proportion still of those invalided for epilepsy and diseases of the nervous system, were under three years' service. The total numbers invalided per 1000 under *three* years' service has varied from a *minimum* of 43 to a *maximum* of 66.

There can be no doubt, however, that the number of men who break down and are discharged as invalids in the first year of their service depends to some extent upon the *quality* of the recruit at the time of his enlistment—the proportion varies from 13 to 21 per 1000 of recruits raised during the year. It also appears that the proportion of men discharged as invalids in their first, second, and third years of service under the short-service system of enlistment

has been somewhat greater than under long service.

Since 1873 the figures, as under, can be regularly shown.

TABLE III.—PROPORTION OF INVALIDS PER 1000 EFFECTIVE DISCHARGED UNDER THREE YEARS' SERVICE IN 1865, AND IN THE PERIOD 1873-1884 RESPECTIVELY.[1]

Year.	Under one Year.	From one to two Years.	From two to three Years.	Total.
1865	15	19	12	46
1873	13	14	23	50
1874	20	18	14	52
1875	17	21	18	56
1876	21	17	19	57
1877	18	23	16	57
1878	18	26	22	66
1879	17	19	22	58
1880	14	21	21	56
1881	14	18	18	50
1882	14	16	14	44
1883	14	18	18	50
1884	11	16	16	43

The larger proportion of these so discharged are under 20 years of age.

But since 1880 an arrangement has been made by which the number of invalids *appears* to be not so great. In the *Report on Recruiting* for that

[1] Appendix F to *Report on Recruiting* for 1884, of date February 21, 1885.

year it is stated that the physical condition of the recruit does not cease to be an object of watchfulness; and to ensure his not breaking down under the change of life and habits, he is for the *first three months* placed under medical supervision; and instructions on this point have been issued to all medical officers.[1] This has been termed "the period of probation" for the recruit. Hence it is to be noted for the first time in the *Army Medical Statistical Reports* for 1882 that 92 recruits, *i.e.* 2.02 per 1000 effective, were found medically unfit for service within *three months* of their enlistment; and in 1884 still more broke down than before within the same time after enlistment.

What this medical supervision amounts to (beyond bringing the recruit before a medical board) does not appear; but eventually the young lad is cast out as "not likely to become an efficient soldier."[2]

[1] General Order $\frac{88}{1881}$, and *Annual Report of Inspector-General of Recruiting*, for 1880, p. 4, of date February 1881.

[2] *Annual Report on Recruiting*, 1881, of date March 9, 1882.

SECTION II

COMPOSITION OF THE BRITISH ARMY AS TO THE AGES OF ITS NON-COMMISSIONED OFFICERS AND MEN

In the previous section it has been shown that "*age*" and "*the management of adolescence*" are of prime importance, and demand our first consideration in dealing with the pathology of disease, especially in military life.

An eminent historian has recorded his opinion that "the foreground of human life is the only part of it which we can examine with real exactness;"[1] and you will find that this is especially true as regards the young soldier. You have him entirely under your observation from the foreground of his life to the end of his career in the service.

The composition of the British army as to the ages of its members has usually been shown in the statistical tables of the Army Medical Department of the War Office by an arrangement of its constituents into *quinquennial* periods as to age. Thus the army has been divided up or classified into six groups:—

[1] *Short Studies on Great Subjects.*—Froude.

The *first* group comprehends all ages under 20 years—the period of adolescence or growth and development towards maturity; the *second* group comprehends all over 20 and under 25 years—the period of completed development or maturity; the *third* group comprehends all over 25 and under 30; the *fourth* group comprehends all over 30 and under 35—the last two groups comprehending men in the prime of life; and the *fifth* group embraces all over 40—men commencing to deteriorate as to their physical powers.

The numbers under each of these groups necessarily vary from year to year; but generally it may be stated that hitherto *one-eighth*, or *one-seventh* part, or *one-sixth* part of our army, or even *one-half* of some regiments has been composed of lads under 20 years of age—lads who have not yet reached the maturity of their development, and who are therefore physically immature.

The number of such immature lads entering into the composition of the army appears to be increasing (and likely to increase rather than to get less), as will appear from the evidence contained in the following pages.

In the following Table IV. is shown the composition of the army AT HOME and ABROAD during the ten years 1876-1885: (1) as to its annual effective strength year by year; (2) as to the number of the non-commissioned officers and men composing it annually at the several ages from under 18, and pro-

gressively year by year up to the 25th year, and above 25 years of age; also (3) the total numbers annually serving (*a*) under 20 years of age, (*b*) between 20 and 23 years of age, (*c*) under 23 years of age, (*d*) between 23 and 25 years of age, and (*e*) above 25; (4) the total average annual strength for the ten years and at each of these several ages and the average annual ratios per 1000 for the whole period.

An analysis of this Table gives an annual average strength of the British army at home and abroad for each of the ten years from 1876-1885, inclusive, of non-commissioned officers and men, of 182,822, ranging from a *maximum* of 192,929 in 1885 to a *minimum* of 173,529 in 1883. It shows that 16.6 per 1000 were under 18 years of age; 33·3 per 1000 18 and under 19; and 66.8 per 1000 were 19 and under 20. It further shows an annual average of 21,357 lads under 20 years of age, ranging from a *maximum* of 31,722 in 1885 to a *minimum* of 16,451 in 1882—a ratio of 116.8 per 1000 under 20 years of age; that 82.1 per 1000 were in their 21st year, with an annual average of 15,013 at that age; 82.3 per 1000 were in their 22d year; and 82.9 per 1000 were in their 23d year; and showing an annual average of 45,230 lads between 20 and under 23 years of age, ranging from a *maximum* of 55,176 in 1885 to a *minimum* of 36,266 in 1876—a ratio of 247.3 per 1000 between these ages; showing a grand total under 23 years of

TABLE IV.—Effective Strength and Comparative Statement of the Ages[1] of Non-Commissioned Officers and Men, from 1876-1885, inclusive, of the British Army at Home and Abroad.

Year.	Strength.	Under 18 Years.	18 to 19.	19 to 20.	20 to 21.	21 to 22.	22 to 23.	23 to 24.	24 to 25.	Above 25.	Total under 20.	Total 20 to 23.	Total under 23.	Total 23 to 25.	Total under 25.
1876	181,875	2,837	6,953	10,364	12,512	11,729	12,025	12,490	13,892	99,073	20,154	36,266	56,420	26,382	82,802
1877	182,332	2,910	6,276	11,741	13,051	13,766	12,673	12,340	12,768	96,807	20,927	39,492	60,417	25,108	85,525
1878	184,067	2,892	5,688	10,077	13,173	13,944	13,791	12,750	11,910	99,842	18,657	40,908	59,565	24,660	84,225
1879	183,942	2.948	5,441	9,912	13,918	15,612	15,927	15,039	13,513	91,632	18,301	45,457	63,758	28,552	92,310
1880	181,283	3,084	6,080	9,556	13,106	14,575	16,372	15,639	14,274	88,597	18,720	44,053	62,773	29,913	92,686
1881	181,742	2,985	3,667	14,022	13,743	14,487	15,326	16,161	15,184	86,167	20,674	43,556	64,230	31,345	95,575
1882	185,518	2,822	1,779	11,850	17,648	14,282	14,251	15,239	16,970	90,677	16,451	46,181	62,632	32,209	94,841
1883	173,529	3,190	6,169	11,078	17,308	18,169	14,673	15,029	14,205	73,708	20,437	50,150	70,587	29,234	99,821
1884	181,008	3,400	8,718	15,410	15,678	16,863	18,518	14,682	14,334	73,405	27,528	51,059	78,587	29,016	107,603
1885	192,929	3,424	10,200	18,098	19,995	17,132	18,049	19,008	14,842	72,181	31,722	55,176	86,898	33,850	120,748
Totals	1,888,225	30,492	60,971	122,108	150,132	150,559	151,605	148,377	141,892	872,089	213,571	452,296	665,867	290,269	956,136
Ratio per 1000 .		16.6	33.3	66.8	82.1	82.3	82.9	81.1	77.6	477.2	116.8	247.3	364.1	158.7	522.8
Annual Averages	182,822.5	3,049.2	6,097.1	12,210.8	15,013.2	15,056	15,161	14,838	14,189	87,209	21,357	45,230	66,587	29,027	95,614

[1] Compiled from the records in *General Annual Returns of the British Army* for each year, from 1876-1885, inclusive.

age of 66,587 lads, ranging from a *maximum* at that age of 86,898 in 1885 to 56,420 in 1876—a ratio of 364.1 per 1000. It further shows an annual average of 29,027 young men between 23 and 25 years of age, ranging from a *maximum* of 33,850 in 1885 to a *minimum* of 24,660 in 1878—a ratio of 364.1 per 1000; and also an annual average of 95,614 rank and file under 25 years of age, ranging from a *maximum* of 120,748 in 1885 to a *minimum* of 82,802 in 1876—a ratio of 522.8 per 1000 under that age. It shows further an annual average of 74,256 lads between 20 and under 25—a ratio of 406 per 1000. Finally, it shows an annual average of 87,209 men above 25 years of age—a ratio of 477.2 per 1000 non-commissioned officers and men.

During the American War of the Rebellion the particulars as to age of 190,621 white natives of the United States are given, whose *mean age* was 26.241 years. The total number of each at 18 years of age was 30,456—the ratio per 1000 being 159.773. The total number at 19 was 14,994—a ratio of 78.659 per 1000; and at 20 years of age there were 14,146—a ratio of 74.210 per 1000 at that age. The total number of men under 20 years of age was 72,527—a cumulative ratio per 1000 of 380.479. The very large proportion at the 18 years is remarkable—*one-sixth* of the whole number of men being included in that year; while the number of men recorded as having attained their 18th and

19th year comprise nearly *one-fourth* of the whole number.[1]

In the following Table V. is shown the composition of the army serving IN INDIA during each of the ten years 1876-1885, as regards—

(1) Its annual effective strength year by year.

(2) The number of the non-commissioned officers and men composing it annually at the several ages from under 18, and progressively year by year up to the 25th year and above 25 years.

(3) The total numbers annually serving (*a*) under 19 years of age, (*b*) under 20 years of age, (*c*) between 20 and 23 years of age, (*d*) under 23 years of age, (*e*) from 23 to 25 years of age, (*f*) under 25 years of age, and (*g*) above 25.

(4) The total average annual strength for the ten years and at each of these several ages, and the average annual ratios per 1000 for the whole period.

An analysis of this Table relating to the composition of the army IN INDIA, as regards its strength and ages of its individuals for each of the ten years from 1876-1885, inclusive, gives an annual average of 60,503, ranging from a *maximum* of 67,000 in 1880 to a *minimum* of 56,383 in 1884. It shows that an annual average of 455 lads *under* 18 were serving in India during these ten years, ranging from

[1] *Statistics, Medical and Anthropological, of the Provost-Marshal-General's Bureau*, vol. i. p. 49, by J. H. Baxter, A.M., M.D., Colonel and Chief Medical Purveyor of United States Army, 2 vols., Washington, 1875.

TABLE V.—EFFECTIVE STRENGTH AND COMPARATIVE STATEMENT OF AGES[1] OF NON-COMMISSIONED OFFICERS AND MEN OF THE BRITISH ARMY SERVING IN INDIA, FROM 1876-1885, INCLUSIVE.

Year.	Strength.	Under 18 years.	18 to 19.	19 to 20.	20 to 21.	21 to 22.	22 to 23.	23 to 24.	24 to 25.	Above 25.	Under 19.	Total under 20.	20 to 23.	Under 23.	23 to 25.	Under 25.
1876	59,174	386	302	724	2,000	2,844	3,255	4,135	5,372	40,156	683	1,412	8,099	9,511	9,507	19,018
1877	58,999	454	356	887	3,212	3,342	3,645	4,001	4,518	38,584	810	1,697	10,199	11,896	8,519	20,415
1878	60,207	437	359	1072	2,220	3,303	4,219	4,220	4,038	40,339	796	1,868	9,742	11,610	8,258	19,860
1879	64,587	468	356	1326	3,372	4,735	5,727	5,750	5,094	37,759	824	2,150	13,834	15,984	10,844	26,828
1880	67,000	454	324	2046	2,907	4,853	6,616	6,887	6,078	37,835	778	1,824	14,376	16,200	12,965	29,165
1881	60,858	372	306	993	2,645	4,355	5,612	6,522	6,217	33,836	678	1,671	12,612	14,283	12,739	27,022
1882	60,274	429	251	723	3,403	3,929	4,900	6,142	6,804	33,693	680	1,403	12,232	13,635	12,946	26,581
1883	56,917	516	226	426	4,332	6,026	5,266	5,857	5,583	28,685	742	1,168	15,624	16,792	11,440	28,232
1884	56,383	492	315	1082	3,123	5,775	7,042	5,887	5,718	26,949	807	1,889	15,940	17,828	11,605	29,434
1885	60,629	539	345	1329	4,614	5,613	6,890	7,666	5,829	27,804	884	2,213	17,117	19,330	13,495	32,825
Totals	605,028	4547	3140	9602	31,828	44,775	55,172	57,067	55,251	345,640	7687	17,295	129,775	147,070	112,318	259,388
Ratio per 1000		7.6	5.1	15.6	50.9	70.4	87.8	94.3	91.3	577.1	12.6	28.2	209.1	237.3	185.6	422.9
Annual Averages	60,503	455	314	960	3,182	4,478	5,317	5,707	5,525	34,564	769	1,730	12,977	14,707	11,232	25,939

[1] Compiled from the records in *General Annual Returns of the British Army* for each year, from 1876-1885, inclusive.

a *maximum* of 539 in 1885 to a *minimum* of 372 in 1881—a ratio of 7.6 per 1000 of annual strength; that 314 lads were serving at an age between 18 and 19, ranging from a *maximum* of 359 in 1878 to a *minimum* of 226 in 1883, and representing an annual ratio of 5 per 1000.

These combined results show an annual average of 769 lads serving in India under 19 years of age, the annual numbers ranging from a *maximum* of 884 in 1885 to a *minimum* of 678 in 1881, and representing an average annual ratio per 1000 of 12.6. The analysis further shows an annual average of 960 lads between 19 and 20 years of age, the numbers ranging from a *maximum* of 1329 in 1885 to a *minimum* of 426 in 1883—a ratio per 1000 of over 15; and that the annual average under 20 years of age serving in India during the past ten years has been 1730, the numbers ranging from the *maximum* of 2213 in 1885 to a *minimum* of 1168 in 1883, representing an annual ratio of 28.2 per 1000 serving under 20 years of age. It further shows that at the age between 20 and 21 there was an annual average of 3182 lads serving in India, their numbers ranging from 4614 as a *maximum* in 1885 to 2000 as a *minimum* in 1875, and representing a ratio of 50.9 per 1000 constantly serving in India.

Further, it shows that between the ages of 21 and 22 there was an annual average of 4478 lads serving in India, their numbers ranging from a

maximum of 6026 in 1883 to a *minimum* of 2844 in 1876, and representing a ratio of 70.4 per 1000 annually serving there; also that between 22 and 23 years of age there was an annual average of 5317 lads serving in India, their numbers ranging from a *maximum* of 7042 in 1884 to a *minimum* of 3255 in 1876, and representing a ratio of nearly 88 per 1000 lads annually serving there at that age.

The total of these results shows an annual average of 12,977 lads between 20 and 23 years of age serving in India, their numbers ranging from a *maximum* of 17,117 in 1885 to a *minimum* of 8099 in 1876, and representing a ratio of 209 per 1000 lads between 20 and 23 years of age annually serving in India at these ages.

Under 23 years of age the total average has been 14,707 lads, ranging from a *maximum* of 17,330 in 1885 to a *minimum* of 9511 in 1876—a ratio above 237 lads per 1000 *under* 23 years of age constantly serving in India.

Between 23 and 24 years of age the average annual number serving in India during the last 10 years has been 5707, with a *maximum* of 7664 in 1885 to a *minimum* of 4001 in 1877—a ratio of nearly 95 per 1000 young men between 23 and 24 serving in India.

Between 24 and 25 years of age the annual average of young men serving in India has been 5525, with a *maximum* of 6804 in 1882 to a

minimum of 4038 in 1878—a ratio of nearly 92 per 1000.

Between 23 and 25 years of age the annual average of young lads serving in India has been 11,232, with a *maximum* of 13,495 in 1885 to a *minimum* of 8258 in 1875, and representing an annual ratio of 186 per 1000 young men between 23 and 25 years of age.

Lastly, the table shows an annual average of 25,939 young men and lads under 25 years of age serving in India, from a *maximum* of 32,825 in 1885 to a *minimum* of 19,018 in 1876, and representing an annual ratio of 423 per 1000.

In the following Table VI. (p. 30) is shown the actual number of *lads* serving each year under 20 years of age, and the total annual strength of non-commissioned officers and men serving AT HOME and ABROAD and IN INDIA only, with the ratios per 1000 for each year.

From this Table it is seen that the ratios per 1000 of *lads* under 20 years of age serving AT HOME and ABROAD have ranged from a *maximum* of 166 per 1000 in 1885 to a *minimum* of 71 per 1000 in 1864 ; and that the *lads* serving IN INDIA only, under 20 years of age, have ranged from a *maximum* of 36.5 per 1000 in 1885 to a *minimum* of 20.5 in 1883.

Generally, also, it is seen that the ratios per 1000 of strength as well as the actual numbers of *lads* under 20 years of age have very considerably in-

creased in the past two years both at Home and in India.

TABLE VI.—NUMBER OF LADS UNDER 20 YEARS OF AGE AT HOME AND ABROAD AND IN INDIA ONLY.

GENERALLY AT HOME AND ABROAD.				IN INDIA ONLY.		
Year.	Lads under 20 years of age.	Strength.	Ratio per 1000.	Lads under 20 years of age.	Strength.	Ratio per 1000.
1864	13,688	191,272	71	...*	...*	...*
1873	17,476	138,803	155	...	...	...
1874	19,764	173,272	112	...	...	...
1875	...	...	97†	...	...	...
1876	20,154	181,875	113	1412	59,174	23.8‡
1877	20,927	182,232	116	1697	58,999	28.7
1878	18,657	184,067	106	1868	60,207	31.0
1879	18,301	183,942	100	2150	64,587	33.2
1880	18,720	181,283	104	1824	67,000	27.2
1881§	20,674	181,742	115	1671	60,858	27.4
1882	16,451	185,518	89	1403	60,274	23.2
1883	20,437	173,529	119	1168	56,917	20.5
1884‖	27,528	181,008	155	1889	56,383	33.3
1885	31,722	192,929	166	2213	60,629	36.5

* Blanks mean that there are no returns.

† From the *General Annual Returns of the British Army* for the respective years.

‡ Calculated out from the above returns of the respective years.

§ By General Order 82 of 1881 the *minimum* age of recruits was raised from 18 to 19 years.

‖ On April 27, 1883, authority was given to enlist (specially) recruits at 18 years of age.

In 1866 a Commission on Recruiting, presided over by an ex-Secretary of State, reported that in 1844 the average of the rank and file *under age* was 25 per cent, and that in 1864 it was $22\frac{1}{2}$ per cent.

But since 1874 the Annual Statistical Reports of the Army Medical Department do not publish details

as to the ages of the men in quinquennial groups composing the army and in relation to disease, as was wont to be done, so that we do not now know how the army is made up in these respects, so important from a medical point of view, except from the records contained in the *General Annual Return of the British Army*, published from year to year. The Reports of the Army Medical Department were wont to be very valuable in these respects, recognising the very great importance of age as a factor to be reckoned with in the incidence of disease. They no longer give in detail the diseases that are grouped together, as was wont to be given previous to 1874; but they give simply a series of tabular abstractions in place of the definite details of disease in relation to ages which distinguished the earlier statistical reports. These were drawn up on a plan, the result of much thought and experience, formulated by two of the most distinguished statists of the day—the late Dr. William Farr, F.R.S., and Surgeon-General Dr. Graham Balfour, F.R.S.

"As regards the relationship between enteric fever and age the statistics of the army in India for 1883 show that 41 per cent of the army was under 25 years of age; and that among them the death-rate from enteric fever was 4.34 per 1000, whilst among men between 25 and 29 years of age, forming 35 per cent of the army, the mortality was only 1.50 per 1000. The susceptibility of young soldiers to this fever is also clearly shown in the length of residence

in India ; for while the death-rate from this fever of those in their 1st and 2d year's service was 4.98 per 1000 ; among those in their 3d to 6th years, and 7th to 10th years, it was 1.55 and 0.55 per 1000 respectively." The experience of newly-arrived regiments also witnesses (as in 1883) to the influence of climate on youth in the production of enteric fever—no less than 8.95 of the total death-rate (19.26) of these regiments being due to this disease.

Additional evidence of the influence of youth and short residence upon the prevalence of this fever is afforded by the statistics of individual stations. At Lucknow, for example, out of 44 cases, 35 of which took place in one regiment composed principally of young soldiers, 33 occurred among men between 20 and 24 years of age, and of less than one year's residence in India.[1]

"For the army as a whole in 1883 in India 36.55 per cent of those invalided were under 25 years of age (the following year, 1884, it was 38.70); while 18.94 per cent of the total invalided (32.66 per 1000—in 1884 it was 24.19) had been less than two years in the country."[2]

Anæmia, debility, phthisis pulmonalis, hepatitis, and diseases of the heart and arteries, are the principal diseases necessitating invaliding from India.[3]

[1] *Report on Sanitary Measures in India in* 1883-84, vol. xvii. p. 3 (Eyre & Spottiswoode. London, 1885).

[2] *Ibid.* p. 4.

[3] *Ibid.*

SECTION III

INFLUENCE OF AGE ON MORTALITY AND SICKNESS IN THE ARMY AT HOME AND IN INDIA, AS CONTRASTED WITH CIVIL LIFE—"THE SHORT-SERVICE SYSTEM" EXPLAINED

THE question may perhaps be put: "What has all this to do with pathology or with the nature of the ailments of soldiers?" It is not the kind of pathology with which, as students of medicine, you may have been accustomed to deal. But you will not be long in this hospital for invalid soldiers before it will become very obvious how much the sickness, the mortality, and the invaliding of the troops are influenced by the ages of the men, just as we have seen how the death-rate and sickness in civil life are influenced by the incidence of age. The evidence also is accumulating, which shows how great an amount of sickness, mortality, and invaliding in the army takes its origin in the injudicious training and occupation of the soldier in the various arms of the service when he is yet in the stage of development and adolescence (*i.e.* of growth towards maturity), and when the constitution of the body is far frailer than in its mature condition.[1]

[1] *The Breakdown of Young Soldiers under Training Explained*, by Surgeon-Major F. Arthur Davy, M.D. (F. J. Cattermole, Woolwich, 1883.)

In the following Table VII. is shown the influence of a
fluence in civil life.

TABLE VII.—THE INFLUEN

Table showing the Death-Rates of the Warrant Officers, N
by Quinquennial Periods, in the seve

(*Army Medical Departm*

Commands.	Under 20 Years.				20 and under 25.			
	Strength	Died.	Ratio per 1000.		Strength.	Died.	Ratio per 100.	
			1884.	1874-83.			1884.	
Gibraltar	594	3	5.05	3.83	2,388	5	2.09	5
Malta	565	5	8.85	4.90	2,716	19	6.99	9
Cyprus	39	..	..	6.85*	249	3	12.05	6
Egypt	398	2	5.02	10.29†	2,749	48	17.46	27
Canada	121	..	..	1.04	745	4	5.37	3
Bermuda	38	..	..	2.75	613	8	13.05	4
West Indies	58	3	51.72	12.02	497	1	2.01	2
Cape of Good Hope and St. Helena	307	1	3.26	14.63‡	1,624	12	7.39	3
Mauritius	25	..	..	..	117	3	25.64	1
Ceylon	13	..	..	3.46	449	6	13.36	1
China and Straits Settlements	26	..	..	5.93	848	5	5.89	
India	1,944	8	4.11	7.70	21,309	324	15.20	1
Troops at Home §	122,195	..	2.19	3.21	32,860	..	4.47	
Civil Male Population ‖ England and Wales	..	..	6.89	..	..	..	8.67	
Civil Male Population ‖ Healthy Districts	..	..	5.83	..	..	..	7.30	

* For five years only. † For 1883 only.

‡ For six years only, viz. 1873-74-75-76-82 and 83, no information having been furnish
the intervening years.

§ *Army Medical Department Report* for 1884, p. 36.

‖ The ratio of mortality of males in the civil population under 20 has been calculated

mortality at home and abroad, contrasted with its in-

AGE ON THE MORTALITY.

missioned Officers and Men at the several Ages, arranged
ign Commands and Home Service.

rt for 1884, p. 232.)

and under 30.			30 and under 35.				35 and under 40.				40 and upwards.			
	Ratio per 1000.				Ratio per 1000.				Ratio per 1000.				Ratio per 1000.	
Died.	1884.	1874-83.	Strength.	Died.	1884.	1874-83.	Strength.	Died.	1884.	1874-83.	Strength.	Died.	1884.	1874-83.
5	4.20	5.14	387	2	5.17	7.12	232	1	4.31	7.92	29	..	..	18.04
10	10.21	7.08	357	3	5.58	8.89	170	4	23.53	12.45	46	..	..	12.09
2	19.80	12.74*	49	2	40.82	6.29*	24	..	..	17.54*	4	..	..	..
10	5.53	20.45†	633	10	15.80	19.28†	331	3	9.06	27.34†	92	1	10.87	71.43†
1	2.49	3.83	159	2	12.58	8.72	104	1	9.61	12.64	15	..	..	18.35
7	13.67	8.98	218	..	..	9.68	76	..	..	8.36	7	1	142.86	24.22
1	5.00	14.83	78	..	..	20.41	39	3	76.92	8.17	9	2	222.22	28.41
8	6.47	31.00‡	356	2	5.62	43.26‡	177	1	5.65	55.79‡	46	..	..	62.73‡
5	29.41	16.19	42	..	..	16.35	20	..	..	11.19	8	..	..	64.52
4	11.46	10.61	65	1	15.38	13.42	23	..	..	24.14	5	..	..	44.94
6	9.26	8.87	199	1	5.02	10.63	82	1	12.19	17.00	52	..	..	28.75
210	11.56	14.75	7727	85	11.00	19.35	3178	40	12.58	21.25	1505	21	13.95	43.42
..	5.68	6.29	7291	..	10.15	10.34	6303	..	11.78	15.82	1828	..	19.85	22.91
..	9.55	..	..	..	10.37	..	..	..	11.96	..	..	..	13.96	..
..	7.93	..	..	..	8.36	..	..	..	9.00	..	..	..	9.86	..

17-20, and that of 40 and upwards for the ages 40-45. The rates for England and Wales
en obtained from Dr. Farr's English Life Table, published by authority of the Registrar-
in 1864, and for healthy districts from Dr. Farr's Healthy District Life Table, published
3d Annual Report of the Registrar-General.

TABLE VIII.—RATES OF INVALIDING AT DIFFERENT AGES FOR UNITED KINGDOM, 1884.

	Under 20.	20 and under 25.	Over 25 and under 30.	Over 30 and under 35.	Over 35 and under 40.	Over 40.
Average Strength	22,195	32,860	13,786	7291	6303	1828
Number Invalided	203	657	355	193	243	101
Rate per 1000	9.14	19.99	25.75	26.47	38.55	55.25

Year by year it is shown that the rate of invaliding increases with each quinquennial period of age; and rapidly in the later periods of life in the service.[1]

It is "*the short-service system of enlistment*" (1870) which now (1887) has been in operation for 17 years that has thus brought markedly into prominence the youthfulness of our soldiers—more especially in the corps on home service. This short-service system of enlistment is one which is based on the principle and developed on the lines laid down by the late Prince Consort, so far back as 1852, in his scheme for obtaining a Reserve Force, which was afterwards so much required in the war with Russia in 1854.[2] But such a force was not then organised, and was not so organised till 18 years later. By this system of enlistment the corps on home

[1] *Army Medical Department Report*, 1884, p. 17.

[2] *Life of the Prince Consort*, by Sir Theodore Martin, C.B., vol. ii. p. 444.

service are now the training schools for the army abroad and for the Reserve. For the theory of the scheme is, "That the home battalions (composed in a great measure of young lads and very young men) shall, in the event of war, be filled from the Reserve, as happened for the first time in the spring of 1878—the men so joining being all trained soldiers, in the very prime of life, who had already passed from 3 to 6 years in the ranks. It became obvious, therefore, that the wants of the army for young soldiers would not likely decrease, but would become more and more urgent, as men were drawn from it to the Reserve."[1] And so it came to pass that the first effects of this short-service system of enlistment (introduced in the autumn of 1870) began to be felt towards the close of 1876; while in the close of 1877 and ever since 1878 (the system coming more fully into operation) large numbers of men having served six or more years with the colours are passed into the Reserve, there to serve for six or more years longer.

The important points for us to bear in mind in connection with these facts (and in addition to the pathological view that I have already formulated respecting the influence of age in relation to disease) is: *That the place of these men in the ranks of the army must necessarily be continuously filled up with younger men; and that on the military medical*

[1] *Report of Major-General E. A. Whitmore, C.B., on Recruiting* for 1876, p. 2.

officers the responsibility is now fixed of determining the ages of these recruits.

In the year 1877 the demand for young recruits was such as to enlist and pass into the service as many as 28,280 during the year, compared with only 6728 in 1862 and 18,575 in 1875. And, going on with this system as a permanent one, the then Inspector-General of Recruits expressed his opinion in his valuable *Report on Recruiting* for 1877 that it would be necessary in the future to raise yearly from 27,000 to 28,000 young men to keep the army at its proper establishment, complete in its numerical strength of say 200,000 men under this short-service system of enlistment. Even that number has in 1886 been greatly exceeded.

It is obvious, therefore, that the more the pressure of this short-service system comes into operation a larger number of recruits will be required annually. In 1885 39,971 recruits were taken.

Hence it must ever be kept in view that we are getting an army composed mainly of very young soldiers for variable periods of service. The "material" composing the army from this point of view has obtained for it a name which has characterised the epoch as that of "The Boy-Soldier Period."

It is this general youthfulness which the name implies, and the danger of insufficient physique of the material likely to accompany youth and the immaturity of adolescence, which are the two most

important factors contributing to the inefficiency arising from disease and ill-health in the army.

The youthfulness of the recruits is shown in Table IX. on the following pages.

Summary of the following Table IX. regarding the Ages of Recruits.—During the 12 years, 1874-1885, inclusive, 335,511 boys and men were enlisted, whose ages ranged from under 17 to over 25 years. Of these 186,372 were lads under 20 years of age (representing an annual average of 15,531 enlistments under 20 years of age) — namely, 12,060 under 17 years; 1678 at 17 and under 18; 81,424 at 18 and under 19; and 91,210 at 19 and under 20.

These give the following *ratios per* 1000 during the 12 years—namely, 35.6 under 17 years of age; 5.0 at 17 and under 18 years; 242.69 at 18 and under 19; and 271.8 at 19 and under 20; with an average annual ratio of 555.48 per 1000 under 20 years of age, *i.e.* from 16 and under 20 years. There were also during the 12 years 45,613 enlisted between 20 and under 21 years—a ratio of 135.9 per 1000; 31,653 enlisted between 21 and under 22 years—ratio of 94.30 per 1000; and 24,852 between 22 and under 23 years—a ratio of 74.7 per 1000. These numbers represent a total of 102,118 enlisted between 20 and under 23 years—a ratio per 1000 of 304.3; and a grand total of 288,490 under 23 years of age—a ratio of 859.8 per 1000 recruits in the stage of adolescence.

TABLE IX.—NUMBERS AND AGES OF THE RECRUITS WHO JOINED SIVE, AND RATIO PER 1000 (amplified from Table XXV., p.

Year.	Under 17 years.	17 and under 18 years.	18 and under 19 years.	19 and under 20 years.	20 and under 21 years.	21 and under 22 years.	22 and under 23 years.	23 and under 24 years.
1874	913	290	5,782	5,000	2,854	2,044	1,455	1,173
1875	948	210	5,173	4,260	2,497	1,763	1,389	1,092
1876	965	234	7,620	6,378	3,782	2,947	2,296	1,817
1877	868	190	7,375	5,961	4,102	2,962	2,383	2,049
1878	976	195	6,822	5,474	4,015	3,210	2,586	2,125
1879	932	135	5,359	4,913	4,282	2,881	2,493	2,190
1880	1,021	156	6,611	5,510	3,667	2,525	2,081	1,785
1881	933	77	3,901	9,508	3,713	2,426	1,959	1,650
1882†	999	28	199	11,992	3,805	2,158	1,683	1,240
1883	1,193	59	7,988‡	11,573	4,491	2,743	1,870	1,481
1884	1,252	65	10,950	10,219	4,060	2,861	2,199	1,828
1885	1,060	39	13,644	10,422	4,345	3,133	2,458	1,919
Total	12,060	1678	81,424	91,210	45,613	31,653	24,852	20,349
Ratio per 1000	35.6	5.0	242.69	271.8	135.9	94.30	74.7	60.6

* By General Order 13, 1877, enlistment over 25 is to be discontinued.

† *N.B.*—By General Order 82 of 1881 the minimum age of recruits was raised from 18 to 19 years.

THE REGULAR ARMY IN EACH YEAR FROM 1874-1885, INCLU-30, of *General Annual Return of the British Army* for 1885).

24 and under 25 years.	25 years and upwards.	Not reported.	Total.	Total under 20.	Total 20 and under 25.	Total under 25.	Total above 20.	Annual rates per 1000 under 20 years.
1,046	95	1	20,653	11,985	8,572	20,557	8,668	580.3
1,032	146	...	18,510	10,591	7,773	18,364	7,919	572.1
1,670	1659	...	29,368	15,197	12,512	27,709	14,171	517.1
2,022	773	...	28,685	14,394	13,518	27,912	14,291	501.8
2,294	338*	...	28,035	13,467	14,230	27,697	14,568	483.9
2,348	363	...	25,896	11,339	14,194	25,533	14,557	437.8
1,968	289	...	25,613	13,298	12,026	25,324	12,315	519.1
1,764	249	...	26,180	14,419	11,512	25,931	11,761	550.7
1,323	271	114	23,812	13,218	10,209	23,427	19,594	554.9
1,459	238	23	33,118	20,813	12,044	32,917	12,245	628.4
1,852	382	...	35,668	22,486	12,900	35,386	13,182	630.4
2,228	682	43	39,973	25,165	14,083	39,248	14,708	629.5
21,006	5485	181	335,511	186,372	143,473	329,845	151,139	
62.6	...	...	Total yearly average, 27,959	555.48	427.6	983.1	...	

‡ On April 27, 1883, authority was given to enlist (specially) recruits at 18 years of age.

Between 23 and under 24 years, 20,349 were enlisted in the 12 years—a ratio of 60.6 per 1000 recruits; and 21,006 between 24 and under 25 years—a ratio of 62.6 per 1000 recruits, representing a total number of 41,355 enlisted between 23 and under 25 years—a ratio of 122.6 per 1000 recruits; and a grand total between 17 and under 25 years of age of 329,845 recruits—a ratio of 983.1 per 1000 between 16 and under 25 years of age.

The annual ratios per 1000 vary from year to year from the lowest—437.8 in 1879 to a *maximum* ratio of 630.4 in 1884.

The total number enlisted between 20 and under 25 years of age was 143,473 during the 12 years —a ratio of 427.6 per 1000.

Such being the composition of the rank and file of the British army at Home and Abroad and in India as to the age of its constituents, and of the recruits who have annually joined its ranks; such being also the influence of age on mortality and sickness, let us look at the results from a practical, anatomical, and physiological point of view.

A pitched battle, wherever active service is going on, is generally, naturally by preference, entrusted, when possible, to carefully-selected old soldiers. But these do not always represent the average efficiency of an army. They are usually a picked body of "commanded men," as they were wont to be called in the old English military language.

And if we look at British soldiers, not as they may be seen in London (where the Guards), or at Portsmouth (where the artillery and marines raise the average to an exceptionally good-looking quality of men), but as you may see them even here (at Netley) or in the garrison towns, and in the depot stations where infantry only are quartered, one cannot fail to notice how largely the "material" of the British army is made up of boy-soldiers.

From time to time the period of service is shortened or extended not as yet upon any fixed principle. There is no finality in practice; but what I wish to demonstrate, and desire that you may appreciate the importance of, is :—*That a very large majority of these young soldiers have not, at the time of their enlistment, reached their maturity of growth nor complete development as regards the bones, the muscles, and the internal solid organs of their bodies, especially the heart, lungs, liver, and kidneys; and it is mainly as regards the details of their immatureness, to which I specially invite attention in the following pages, as bearing upon and explaining to some extent the pathology of many ailments to which they are more prone than lads of the same age who remain in civil life.*

I wish to lay before military and medical officers alike such materials and information as may satisfy them, and all others whom it may concern, in what respects these young lads are *immature*, and how such *immaturity* affects their efficiency as soldiers in

the ranks: (1) As to bodily endurance or "staying powers" and general aptitude for military life; (2) As to their liability or proclivity to certain diseases, which (as compared with civil life) are exceptionally prevalent amongst soldiers.

SECTION IV

QUESTION AS TO THE FITNESS OF LADS UNDER 20 YEARS OF AGE FOR GENERAL MILITARY SERVICE

THERE now comes to the front the very important question for consideration as to the fitness for general service of young men under 20 or 21 years of age, *i.e.* service in war-time and in the field, at home or abroad, as well as at home only, and in peace-time.

Opinions ever have varied, and still continue to vary considerably, as to the reply to this question. But the reply ought to be matured by this time, and quite unanimous, as the result of such an ample and a death-dealing experience as this country has gone through.

General Sir R. C. H. Taylor, K.C.B., in his valuable Report on Recruiting (when he was Inspector-General of Recruits), admits that "men of full ages (and not lads of 18) are preferable as soldiers." Yet it must be remembered that for many years, certainly from the beginning of the present century, the age of 18 has been held to be that at which a

youth is fit to do duty in the ranks, and to be counted as a man. And no doubt the records of some celebrated campaigns may prove that many such boys have rendered good service in the field—boys will always fight when well led, so long as they have strength to fight; yet the records of most wars and of campaigns *of any considerable duration*, as well as the weight of competent individual evidence, are altogether against the employment of lads under 20 years of age as soldiers in the ranks, and for general service in the field. They have not the necessary powers of endurance; and endurance, or "staying-powers" is the grand "test-ordeal." General Taylor also makes the important statement that "the changes in the constitution and organisation of continental armies now render it perilous for this country to rely to so great an extent as formerly on its undeveloped manhood."

On the other hand, a not less eminent authority and distinguished general, Viscount Lord Wolseley, says: "Give me young men" (he does not say how young)—"they do what they are bid, and they go where they are told; they become more amenable to discipline, and, though when you catch them first, they may have some difficulty in carrying their knapsacks, once they get beyond that they are in a fit condition to take the field."[1] This opinion of Lord Wolseley's, I conclude, has reference mainly to

[1] Mr. Hardy's speech in moving army estimates, *The Times*, March 3, 1870.

military discipline rather than to physical capacity for work and general service at an early age.

The experience of all great commanders, and of warfare generally, has shown that young men *have not been* usually able to surmount the fatigues of a continuous military life, especially in the field, under 20 years of age—that they have had great difficulty in carrying their knapsacks in active service when a campaign is prolonged beyond a few months in an enemy's country; and it is quite clear, from the immature condition of his bones, and want of development of his muscles and of his internal organs, that the recruit ought not to pass into the ranks for general service below the age of 20 years.

Some years ago it was given to be understood that none would be *enlisted for service in India* under 20, and finally under 19 years of age, unless for special reasons; yet what do we see in the records for 1873? Over 3500 lads under 20 years of age serving there! and with what dire results to them, the influence of age on sickness and mortality abundantly shows.[1] (See also Table VII.)

The European army in India is, in fact, a young one, only 2 per cent 10 years ago being over 46 years of age, and only 14 per cent above 35; 86 per cent of the total are men below 35 years old, 65 per cent are under 30, whilst the restrictions placed of late on sending young immature soldiers to India have resulted in this: that while the numbers

[1] See *Army Medical Department Report* for 1876, p. 200.

above the age of 25 have been over an average of 577 per 1000 annually, from 1876-1885, inclusive, 12.6 per 1000 have been under 19 years of age, 28.2 per 1000 under 20 (a *maximum* of 2150 serving in 1879, and a *minimum* of 1168 serving in 1883, at that age); while between the ages of 20 and 23 the ratio is as high as 209 per 1000 at that very critical period of adolescence; 237 per 1000 under 23; and nearly 423 per 1000 under 25, out of an annual average of 60,503 rank and file.

All that can be said is that there are still far too many lads under age in India, the effects of which will no doubt be traceable in the future death-roll of our army there.

The records of history are full of evidence as to the unfitness of youth during adolescence for general military service, and still more so in India and the Tropics.

During the military operations in Egypt from 1798-1802, a contingent of European and Sepoy troops was sent from India to Egypt to co-operate with the force under Sir Ralph Abercromby, just as recently they were sent from India to co-operate with the force under Lord Wolseley. Of that contingent (in 1798) it is recorded that "the 68th Regiment which came from Bombay was chiefly composed of boys, and that on the passage fever broke out amongst them, and that they lost nearly half their number, and continued so unhealthy that

they were re-embarked and sent back to Bombay; while the 61st were nearly all old soldiers, and owing, it is said, to the strict discipline and care of Colonel Carruthers, although they were over 900 strong, and had been 16 weeks on board ship, when they landed at Kossir had only one man on the sick list."[1]

But this question as to the fitness or the reverse of young soldiers for general service receives the most marked illustration in the historical records which exist as to the marching powers of the British troops, as recorded by competent authorities. Such records furnish the most telling evidence we possess of the unfitness of youth for such severe exertion as long-continued marches entail.

In the great march of General Roberts from Cabul to Candahar in 1880, it was the young soldiers who succumbed to its fatigues, while the old soldiers became hardier and stronger every day. For example, it is on record, that the 72d Highlanders received two large drafts of young soldiers while at Cabul. They had (on August 28, 1880) absent from their ranks, from maladies incidental to hard marching and exposure to the sun, a much larger number of men than the 60th Rifles and 92d Highlanders, whose ranks were mainly composed of seasoned and matured soldiers.[2]

[1] *A Short History of Naval and Military Operations in Egypt* from 1798-1802, p. 151, by Lieut.-Col. Sir John M. Burgoyne, Bart.

[2] *The Times*, October 7, 1880.

A further retrospective analysis of this great march from Cabul to Candahar, through an enemy's country, and at the end of a long and severe campaign, is of much interest with regard to the endurance, power, and stamina of British troops as compared with some other forced marches. Sir Thomas Crawford, the present Director-General of the Army Medical Department, has given us its most salient points.

The facts of the Cabul and Candahar march are as follows :—

This march[1] had of course to be conducted without a base of operations or communications of any kind, through a hostile country, towards a definite point (Candahar). The arrangements for the march were made by Surgeon-General Sir James Hanbury, at that time Deputy-Surgeon-General in India. It commenced on August 9 ; and Ghazni, a distance of 97½ miles, in which the Zamburak Pass (7000 feet) and the Sher-i-Daban Pass (9000 feet) were crossed, was reached on August 15, *i.e.* in 6 days. For this part of the march, an average distance of nearly 14 miles was covered daily. The remaining distance of 134½ miles was covered in 8 days, or nearly 17 miles daily. 10,148 troops, 8143 native followers, and 11,224 animals, including cavalry horses, composed the moving column ; the daily supplies for all these were drawn from the country around after arrival in camp. Food was distributed

[1] *Army Medical Department Report* for 1880.

and cooked with fuel (difficultly procurable and brought in from a distance) during the 8 days' march. The longest marches on any one day were 20 miles, from Ghazni to Zerghalta, and 21 miles, from Mukur to Panjak.

The larger the body of men the slower the march.

It may be interesting to refer here to some other marches recorded. In July 1809 General Crawfurd marched with the 43d, 52d, and 95th Regiments of Foot to reinforce Sir A. Wellesley, in Spain, at the Battle of Talavera; the brigade marched 62 miles in 26 hours, carrying arms, ammunition, and pack —in all, a weight of between 50 and 60 lbs. per man.[1]

In the late Franco-German War very long and difficult marches were performed by the Germans. Dr. Roth, who served as chief medical officer with the Saxon army, mentions that the 18th Division marched, from October 29 to November 17, $55\frac{1}{2}$ German miles, which is equal to 260 English miles, in 9 days—nearly 18 miles a day; while on December 16 and 17, in the various manœuvres about Orleans, they marched 54 English miles. They were very heavily accoutred, and the roads

[1] Of the weight carried here there is some doubt. In the Peninsular War the men carried bags (or pocks) like grain bags, weighing about 2 lbs., and not framed packs. The late Lord Clyde saw the men marched in, and they each carried a shirt and a spare pair of boots or shoes. The distance also is disputed (62 miles in 26 hours, *i.e.* 2.38 miles an hour, without halts). Sir W. Cope (an officer of the 95th) says the distance was only 40 miles (*History of Rifle Brigade*, quoted in Parkes's *Hygiene*, p. 591). "When a large army moves (say over 10,000 men), it has never accomplished such distances."—Parkes.

were bad. A company of a regiment of Chasseurs of MacMahon's army, after being on grand guard, without shelter or fire, during the rainy night of August 5th-6th, started at 3 in the morning to rejoin its regiment in retreat on Neiderbronn, after the battle of Weissenburg. It arrived at this village at 3.30 in the afternoon, and started again for Phalsbourg at 6 o'clock. The road was across the hills and along forest tracks, which were very difficult for troops. It arrived at Phalsbourg at 8.30 in the evening of the next day. The men had therefore marched part of the night of August 5th-6th, the day of the 6th, the night of the 6th-7th, and the day of the 7th till 8.30 P.M. The halts were 8 minutes every hour, from 3.30 to 6, one hour in the night of the 6th-7th, and $2\frac{1}{2}$ hours on the 7th; altogether, including the halts, the march lasted $41\frac{1}{2}$ hours, and the men must have been actually on their feet about 30 hours, in addition to the guard duty on the night before the march. The exact distance is not known, but, considering the extreme difficulty of that rugged mountain country, and the bad weather, this is, perhaps, the most toilsome march on record. Also Lord Clyde's march, from Lucknow to Cawnpore, must not be forgotten.

Next to fighting, a march through a hostile country is the most trying of military exertions; and a common object of reproach to the British army has ever been that it fights better than it marches—an adverse criticism made not only by foreigners, but

by Englishmen ; and the reason for which is not far to seek. To the civilian mind it appears somewhat strange that a healthy, tolerably active Englishman should think himself overtasked if required to march 20 miles a day for several days in succession. There are plenty of wiry Highlanders, active Irishmen, and sturdy English peasants, who would treat a walk of 30 miles a day, or even more, as a joke. How is it, then, the civilian asks, that we so often hear of soldiers falling out when marching along one of the best roads in the kingdom some 8 or 10 miles, as from Aldershot towards Windsor ?

One explanation is, that the civilian walks by himself as free and easy as he pleases, not as one in a long column ; his dress gives full play to all his muscles, and permits of easy circulation to the blood in his veins ; he carries nothing, or, at most, a light handbag ; he can regulate his pace, according to his powers, and can stop to rest when he chooses. A soldier, on the contrary, marches as one of an organised crowd, and in a series of movements which are to a certain extent "constrained," in a more or less stiff attitude, which the late Dr. Parkes described "as the position of 'attention' put in motion." He consequently suffers more from heat than does the civilian, and is often stifled by the dust raised by those in front of him ; he carries a heavy load ; he wears a dress which, save in India, is not suited for active exercise ; he is girt round with straps which impede the circulation. Tired or fresh, with short or long

legs, he must proceed at a regulated pace, and can only halt when ordered. Worst of all, by checks in the column, over which he has no control, the soldier is often obliged to halt or crawl, thus greatly increasing his fatigue.[1]

Seldom, however, has General Roberts's march been surpassed. It is considered good marching in Europe for a large body of men to travel on tolerable roads, day after day, for any length of time, more than an average of 10 miles a day, including halts. But General Roberts, moving through a difficult and hostile country, over a single indifferent road, at a hot season of the year, did, on an average, cover a little over 16 miles a day for 23 continuous days; 18 to 20 miles for one day is considered a long march for a large body of men. Hence continuous marching in a prolonged campaign is the most testing ordeal as to endurance of the soldier; and the experience of all nations has demonstrated the uselessness of attempting to conduct military operations to advantage, unless the rigid scrutiny of the army medical officer has been able to exclude such men as were unfitted to sustain the continued fatigue and exposure of the march.

The fever engendered by over-exertion is a very characteristic one, due to the proteid embarrassment of the system, which results from the functional destruction of the tissues.[2] The extent to which such

[1] Parkes's *Hygiene*, p. 587.

[2] *The Animal Alkaloids*, by Wm. Aitken, M.D., F.R.S., p. 19, 1887.

destruction and disintegration of tissue takes place may be also realised from the following record given by Mr. Maclaren of Oxford :[1]—

"During a long pedestrian tour (equal to a long march), exceeding 9 hours daily, with knapsack of 12 lbs., the chest fell from 41 to $39\frac{1}{2}$ inches; the upper arm from $14\frac{1}{2}$ to $13\frac{1}{4}$ inches; the lower arm remained unchanged at $12\frac{1}{2}$ inches; the lower limbs, on the contrary, were vastly increased, the calf of the leg passing from 16 to $17\frac{1}{4}$ inches, and the thigh from $23\frac{1}{2}$ to 25 inches."

If such be the result from a pedestrian tour for pleasure, how much more irksome is that of the soldier on the march.

It will be my duty to show you that the younger the recruit under 20 years of age, the less perfect is the growth of his skeleton, and of such important organs as the heart, the lungs, the liver, and the kidneys, the less is his body weight and bulk, and the less able is he for military work. At 18 years of age many recruits are but slim lads, whose bones have not yet completed their growth, and who have not yet attained their full height, bulk, and development. It is hardly reasonable to expect the same work and exertion out of a lad of 18 to 20 years, as out of a full-grown man of 25 to 30 years of age; yet as soldiers they are (young and old alike) worked together in the ranks, and if the young do not possess unusual strength and stamina of constitution, they

[1] Page 13 of work on "Training."

pass most of their time in hospital, till they are discharged as invalids unfit for further service.

It is on account of the large proportion of invalids that the ages under 20 in the Table VII., p. 34, showing the influence of age on mortality, appear at first sight to show favourable results. Hence it is necessary to show the ratio of invaliding as well as the ratio of mortality. And, again, when we come to analyse the influence of age on *sickness* in the *Army Medical Department Reports*, we find that the highest ratios of sickness per 1000 are for the group of ages under 20, and next to that for 20 and under 25.

In addition to the historical examples which have been given there is abundant individual evidence of experienced soldiers and military medical officers to show the utter unfitness of lads under 20 years of age for general service in the field, *i.e.* for active service in a continuous campaign.

The late Dr. Parkes has put his valuable opinion on record in these words: "That although a recruit may be usefully *trained* at an early age, no man under 20 can be regarded as an efficient soldier fit for active service." And here it is worthy to note that "training" is to be distinguished from "active service,"—a very important distinction to be ever kept in view. Parkes goes on to say that, "strong opinions have been expressed by Ballingall (English army), Lévy (French army), Hammond (American army), and other army surgeons, that the age of 17

or 18 is too low—that the youngest recruit should be 20 or 21 years of age. This opinion is based both on actual experience of the effect produced on growing lads of 17 to 20 when exposed to the hardships of war, or even to heavy duty in time of peace, and on a physiological consideration of the extreme immaturity of the body at 18 years of age.

"With regard to the first point, there is no doubt that to send young lads of 18 to 20 into the field is not only a lamentable waste of material, but is positive cruelty. At that age such soldiers, as Napoleon said, merely strew the roadsides and fill the hospitals. The most effective armies have been those in which the youngest soldiers have been 22 years of age."[1]

With regard to the second point—the anatomical and physiological immaturity of the recruit—abundant evidence will be set forth in the next section.

Again, Sir James M'Grigor, a former Director-General of the Army Medical Department, who served throughout the Peninsular War, from 1805-1814, testifies that "corps which arrived for service in the Peninsula were always ineffective and sickly in proportion as they were made up of men who had recently joined the ranks; and in making calculations for measures in the field he found that 300 men who had served five years were more effective and more to be depended on than a regiment of 1000 men who had just arrived, and who were young

[1] Parkes's *Hygiene*, 6th edition, by Dr. De Chaumont, p. 528.

recruits—lads unequal to the harassing duties of service—an experience, he says, which is still more true regarding India.[1]

Many examples of similar opinions are to be found in the records of our Russian War experiences of 1854 and 1855 as contained in the evidence taken by Mr. Roebuck's Committee in the House of Commons. These records show that young and *growing lads* are much less able to endure the fatigues of marching than mature men. When the Duke of Newcastle (the Minister for War at that time) informed Lord Raglan (the Commander-in-Chief in the Crimea) that he had 2000 recruits ready to send to him, Lord Raglan's reply was, "Those last sent were so *young* and *unformed* that they fell victims to disease, and were swept away like flies. He preferred to wait," rather than have such young lads sent out to him as soldiers.[2]

H.R.H. the Duke of Cambridge testifies in the same Report that the young men suffered twice or three times as much in the Crimea as the men who had been there all the time.[3]

Sir De Lacy Evans, in the same Report,[4] states that the drafts sent to him were composed of men too young. General the late Viscount Hardinge[5] also bears testimony to the fact that many men were sent out to the Crimea as a Reserve composed of

[1] *Medico-Chirurgical Trans.*, vol. vi.
[2] Fifth Report on Army before Sebastopol.
[3] *L. c.*, Question 4204.
[4] *L. c.*, Question 755.
[5] *L. c.*, Question 20,773.

young recruits ; and he further states (as if it were an achievement to be imitated as an example) "that these young recruits were made perfect in their drill in the course of *sixty days*," whereas the most competent authority tells us that it takes a year and a half to accomplish the drill education of a soldier—that is to say, the work of 547 days had to be accomplished in 60 days. "Give us," says Lord Hardinge, "a good stout man, and let us have 60 days to train him in, and he will be as good a soldier as you can have. Such had been done in the Peninsula." This may or may not be the case as regards good stout (or mature) men ; but it certainly cannot be done with impunity as regards "growing lads" under *twenty* years of age. If in the given time of *sixty days* the young recruit may be made perfect in his drill, another contingency must be reckoned with—namely, that in less than *sixty days* he may have broken down so completely under the unwonted exercise, that before two more years have passed over his head he may be a dead man ; or having spent most of his time in hospital, he may have been discharged the service as an invalid on account of cardiac or pulmonary disease. While, therefore, he becomes for the remainder of his short and miserable life a burden on the civil population, his death does not show as a death in the service.

Lord Hardinge further goes on to state, "that although no men were sent under 19 years of age, yet when sent out, it was found that instead of

being composed of bone and muscle they were almost gristle." In fact, he says, they were too young; and he seemed to think that limiting the age to 19 was a sufficient restriction in sending out men. The relationship of gristle to youth has not been quite understood or appreciated as it ought to be by military commanders. It is only now that some of them are beginning to understand it; but of this there can be no doubt that boys were sacrificed in the Crimean War because we had no Reserves; and the Short-Service System was doubtless intended to prevent such a thing occurring again, by giving us a reserve of older soldiers and mature men for active service in place of young lads. The first Duke of Wellington considered that old soldiers were the "soul and strength" of the regiments. The late Viscount Cardwell and the present Lord Cranbrook have expressed themselves in much the same terms; and the first Napoleon after the battle of Leipsic said, "I must have grown men; boys serve only to fill the hospitals and encumber the roadsides."

The experiences of the Franco-German War are similar to those I have quoted with regard to our army.

Experience has taught continental states and also this country that men are in general not able to surmount the fatigues of a military life under 20 years of age—a fact long ago pointed out by a famous army surgeon, Dr. Marshall.[1]

[1] Marshall on *Enlistment*, p. 8.

The evidence of M. Coche is to the same effect: "Recruits at 18 years of age are commonly unfit for the duties of an army. If they do not possess unusual strength, they pass two, three, or more years in hospital if they are not discharged the service altogether before that time." [1]

The American authorities have recently taken a still more unfavourable view of the service of young soldiers.

In the Annual Report of the Surgeon-General of the United States Army for 1885, it is shown that a greater proportion of invalids was furnished by troops under 31 years of age; while, up to the age of 25, *the rate proved so much above the mean for the whole army*, that the Surgeon-General states, "It may be fairly questioned whether the services rendered by these young men are equal to the cost of their maintenance." [2]

"These facts show how wrong it is to expect any great and long-continued exercise of force from lads so young as 18 and 20; and the inevitable consequences of taxing them beyond their strength." [3]

But these facts are not to be taken as arguments *against the enlistment* of lads under 20 years of age; they *must*, however, be taken as arguments *against such lads being used or counted upon as efficient soldiers in the ranks at ages under twenty years.*

[1] Marshall, *l. c.*
[2] *Lancet*, January 1, 1887, p. 54.
[3] Parkes, *l. c.*, p. 529, 6th edition.

To get out of the difficulty connected with youthfulness, it has been considered by some as most desirable that none but well-grown men of 20 years and upwards should be enlisted as soldiers; but the simple fact is, that in prosperous conditions of the labouring classes a military career does not offer sufficient advantages to men of that stamp who have already entered upon trades, professions, and other avocations; so that unless higher inducements are set forth, a large proportion of recruits must continue, with the present system, to be furnished from the youths of from 18 to 19 years of age, who have not settled down into any fixed mode of occupation, or who have failed in obtaining a livelihood by regular labour.[1] Moreover, as the Duke of Cambridge has often stated, "Not only is it impracticable to get recruits to enlist at the ages of 20 or 21 years, but the balance of experience shows that they make better soldiers when their training begins at an earlier age."[2]

The necessary outcome of these facts and arguments is that a lengthened period of probation to give time for a course of judicious training is required to enable the recruit to develop his strength, and to learn to husband it, so that he may be able to surmount the fatigues of military duty.

The case therefore seems to stand thus: "If the State will recognise the immaturity of the recruit of 18

[1] *Report on Recruiting*, by Colonel Taylor, *l. c.*
[2] *Times*, March 3, 1876.

years of age, and will proportion his training and his work to his growth, and will abstain from considering him fit for the heavy duties of peace and for the emergencies of war till he is at least 20 years of age, then it would seem that there is not only no loss but a great gain by enlisting men early. At that most critical period of life recruits can be brought under judicious training, when they also ought to have precisely the amount of exercise and the amount and kind of diet[1] best fitted for them, so that in two years they may be more fully developed, and be made more efficient than if they had been left in civil life." [2]

If we may venture further to draw conclusions from the excellent Reports on Recruiting made in recent years by Major-General E. G. Bulwer, when Inspector-General of Recruiting, this is theoretically the conclusion accepted by the military authorities themselves. It is obvious that we are obtaining soldiers at a rate unexampled in this country; that the military authorities recognise a steady gain in our military resources year by year during the past ten years, representing large additions to the Regular

[1] The insufficient food supply of the army has been often represented to the authorities by medical officers. The meat ration provided for soldiers consists of only three-quarters of a pound of meat a day for each man, which, when cooked, weighs only from four to six ounces. This amount of *meat* food is not sufficient to keep a grown man in health, if he has to do any amount of work to cause fatigue; and it is far too small to enable the growing lads who form our recruits to attain their proper growth.—Parkes, *l. c.*, p. 557.

[2] Parkes, *l. c.*, 6th edition, p. 529.

Army and First-Class Army Reserve ; that while the average increase and decrease of the army during the ten years preceding the introduction of the Army Enlistment Act of 1870 are less compared with the corresponding average during the past ten years ; and that, taking the total increase and decrease for the two periods, the result is that while in the former period there was a loss of close upon 40,000 men, in the latter period there has been a gain of close on 53,000 men. "It must not be forgotten that *the great increase in the number of young men coming into the army, and the operations which the army has been forced to undertake from time to time*, have put a great strain on the system.

"Taking the infantry alone, the despatch of extra battalions recently to Egypt, as well as the continuous supply of drafts for foreign stations, have filled the depots and battalions at home with young men. In the case of battalions on the low establishments they are practically depots, and useless for garrison duties. There is no doubt that each battalion ought to have, independent of its recruits and of men preparing for drafts, a sufficient proportion of effective men present and ready for any garrison or other duties the battalion may be called on to perform. It is a question of larger establishments and of a more uniform strength."[1]

Major-General Bulwer justly considers this "an important question, greatly bearing on recruiting, for,

[1] *Report* for 1885, dated March 1, 1886, p. 16.

if men are unduly worked, as they always will be in very weak battalions, the army obtains a bad reputation, and becomes less popular with those to whom we look to fill its ranks.

At one time also there was a great cry raised against the recruits, because they were not effective as soon as could be wished. This was no fault of the men; they are taken young; and Major-General Bulwer in several of his Reports justly contends that "*they must be given time to mature;*" and "that no men, no army, and no system will stand the strain unless the home establishments are maintained at a strength sufficient to meet the demands made upon them."[1]

Again, as regards the physique of recruits, men between the ages of 18 and 20 have great room for development, and there is abundant testimony to the marvellous progress both in height, weight, and chest-measurement, which is made during the first few months of service.[2]

Moreover, "while so many recruits are wanted, it will be necessary to take young men, and, *provided time is given them*, they ultimately become the best soldiers." . . . It has been found in some instances, where complaints have been made as to physique, that the increase gained on re-measurement after a few months is very remarkable. In one regiment, in the case of 16 men who had been specially

[1] *Report on Recruiting* for 1885, dated 1886, p. 16.
[2] Major-General Bulwer, *l. c.*, p. 7, *Report* for 1885.

enlisted, the average chest-measurement increased in the course of a few months from $33\frac{5}{8}$ to $35\frac{3}{8}$, and the average weight from 125 to 140 lbs.

Again, in the *Report* for 1883 Major-General Bulwer observes that "with regard to age there is no doubt that lads at the age of 18 are young and require time to develop; but it is a fault on the right side; and it is hardly fair to judge of these men, or of the men slightly under the *minimum* standard, until it is seen how they develop. It is safer to be guided by the medical judgment than by any other." Again, though it is necessary to have a *minimum* standard, "there are many cases in which men slightly under the standard will in reality become better men than some others over the standard. For this reason it is desirable that whatever standard is fixed some discretionary power should be given jointly to the commanding officers and medical officers on the spot. These officers are not infallible, but they are of standing and experience, and are certainly not likely to pass men wilfully into the service who, in their opinion, will not *with time* become efficient soldiers."[1]

The evidence of Major-General E. A. Whitmore for 1876 is much to the same effect; and Major-General R. C. H. Taylor, in his *Report on Recruiting* for 1875, of date January 1, 1876, paragraph 35, suggests, "as an additional means of furnishing the increased supply of recruits, which it has been

[1] *Report on Recruiting* for 1883, of date February 28, 1884, p. 5.

shown will in future be required, that the practice of enlisting boys from the several industrial, district, union, and other schools shall be still further extended. At present only a limited number of boys in excess of the number authorised as band-boys, drummers, etc., are allowed to be taken for training in regiments, brigades, and corps; and this for the very cogent reason that each boy thus enlisted counts as one of the establishment, and is thus reckoned amongst the effective sabres or bayonets. But if authority were given for the enlistment of a larger number of boys *in excess of the establishment*, to be retained at the depots or at their present schools until they reached the age of 17 or 18 years, during which time they should attend to study, be instructed in trades (this should be imperative), and thoroughly drilled, besides being put through a course of gymnastics, it is believed that a very valuable element would be introduced into the army, and that from this source many good non-commissioned officers especially would be obtainable, supplying thus a want from which many corps are now reported to suffer. From information that has been received, it would appear that any number of such boys may be obtained; and if the principle were adopted and the proposal reduced to a system there is no doubt that a regular flow of young men of a superior stamp would be added to the service, aiding in a large degree towards filling the vacancies that will occur from the constant passing of short-service men into

the Reserve, and supplementing in a most satisfactory manner the ordinary recruiting of the army." Much more ought to be made than hitherto of the corps on home service, as training schools for the army.

By General Order $\frac{88}{1881}$, "All soldiers are kept under the observation of medical officers during the first three months of their service, and are reported on once a month." Therefore, it is that "whenever, during this period, a man shows indications of want of stamina or physical inferiority, he is brought before a medical board, and if the board considers that he will not ultimately become fit for military service, he is at once discharged as 'not likely to become an efficient soldier.' 'Instructions on this point have been issued to all medical officers.'"

But a three-months' period of probation is not enough. Recruits ought to have at least two years for training and physical development after enlistment at 18, before they pass into the ranks, having then completed their 20th year. This necessity will be borne out when we consider the facts set forth in next section, regarding the development and growth of the recruit, and of his internal organs at the period of adolescence.

It is now well known that age, weight, height, and girth are very closely correlated in the growth of a healthy human being to the full development of his strength and powers of endurance, and the due proportions of these factors are absolutely necessary to be maintained in order to enable a man to go through

the fatigues and hardships incident to a military life. *Age* is only *one* of *several* most important elements, and when the bones of the skeleton are examined, and the following sections studied, it will appear that up to the age of even 30 years the skeleton framework of the body is still growing and increasing in bulk, and that the whole man is only arriving at maturity. Such a study ought also to convince any one of the necessity of great care and caution in handling young men and young animals, in order that they may be trained with success without inducing disease. Farmers and trainers of race-horses are now beginning to understand the importance of attending to the due concurrence of age, weight, and perfected development in the training of horses and other animals. The advice of an eminent professor of veterinary pathology—Professor Varnell—on this important subject, to the students of his college, is characteristic of scientific progress: "As men of science," he says, "you ought to point out the folly caused and the deterioration and suffering induced by training and running horses at an age long before they arrive at maturity. Many young horses are trained when not more than a year and a half old, and a large proportion of them are thereby lamed for life. Their joints become diseased, their ligaments and tendons strained, and their bones and the membranes covering them inflamed. In this condition they are placed in the hands of the veterinary surgeon, very often with a peremptory

order to fire and blister the affected limbs. Instances are not unknown when only one leg is affected for a request to fire the opposite one also, on the supposition that it would be strengthened by the operation. If the suggestion is acted on, the poor animal's legs are cauterised with the hot iron, and he is again handed over to the trainer. Such a horse might stand the training, but in all probability he would break down the first race he ran."

It has been recently proposed to purchase horses at an early age, and keep them till old enough for service; and if such is recognised as good for horses, it is still more necessary that young lads should have a sufficient period of probation for growth and training.

SECTION V

PROGRESSIVELY GRADUAL DEVELOPMENT, AND GROWTH OF THE RECRUIT AND THE YOUNG SOLDIER

FROM what has been stated, it will be seen that in the selection of recruits and the training of them for military service, it is necessary to have some standard by which we may compare each individual; and such a standard of comparison can only be safely arrived at (1) by a knowledge of details as to the rate of human growth at the growing age, and by a knowledge of the development of the organs of man, and of the periods at which they, together with the whole body, arrive at maturity; and this not only as regards the several bones of his skeleton, but also as regards the several visceral solid organs inside the great cavities, especially the Heart, the Liver, the Lungs, and the Kidneys; and (2) by a knowledge of the size and weight of men and of lads at different ages.

When we consider fully the details to which I am about to direct attention, you may, perhaps, appreciate better the value and importance of the instruc-

tions which will be given you by the professor of hygiene regarding the *physical training* most proper for the young *soldier*,—a training which, while it tends to develop his strength commensurate with his growth and with his years, tends also to preserve him from disease, and fits him more efficiently to learn and to endure the labour of military duties and drill.

All the parts of the organisation of man are connected or correlated together, so that with the increased or decreased dimensions of the whole body, or of any particular part of it, certain organs are also increased or diminished, or modified; and modifications which arise during the earlier stages of growth tend to influence the subsequent development of the whole man.

The comprehensive question of development and growth is, therefore, of great importance for our present subject—namely, the selection of lads for military service. It must be remembered that the human being reaches maturity by, or through, a vast number of changes, which are individually very slight, and which are also very slowly effected—as when the child grows into the man. Each microscopically minute element of the separate tissues and cells of the body has an independent functional life, so that the constituents of each organ and system have each their own proper life. The osseous system, the nervous system, the heart, the lungs, the liver, and even the blood itself—all of them possess conditions

of nutrition peculiar to the constituents of each of them; so that each goes slowly through its phases of development, of growth, of decay, and of death.

In the regular growth of the skeleton and in its repair, the tissues composing bone and cartilage undergo a whole series of permutations and substitutions throughout childhood, youth, and adolescence. Each organ and part of the body thus reaches maturity through a longer or shorter course of developmental changes; and these changes are necessarily small and insensibly slow, as when a child grows up into a man.[1]

The term "*growth*" implies therefore "the gradual increase to full size by the addition of matter;" while the term "*development*" signifies the advancement of an organised being from one stage to another by a process of natural or inherent but gradual evolution, with certain changes of structure, in passing from a lower or less perfect stage, through others of greater maturity, towards a more complete or finished state. It implies at the same time a gradual growth or advancement through progressive changes from the embryo state to complete maturity, when development ceases but growth may still continue. The brain in idiots continues to grow after having been arrested in its development.[2] Development, therefore, implies growth with the full progress and advancement proper to the original idea, type, or in-

[1] Darwin, *Animals and Plants*, vol. ii. p. 389.
[2] Professor Marshall, *Phil. Treas.*, 1864, p. 544.

tention, or power *in posse* of the object developed—the disengagement of the form or shape from that which conceals its character—

> "Take him to *develope* if you can,
> And hew the block off, and get out the man."
> POPE, *Dunciad.*

A child is said in this sense to grow into a man, and a foal into a horse; but, as in these cases there is much change of structure, the process properly belongs to the order of development. We have indirect evidence of this in many variations of structure and of diseases supervening during so-called growth at particular periods, these being inherited at corresponding periods. In the case, however, of diseases which supervene during old age, and which nevertheless are sometimes inherited (as of the brain and heart), these organs only became visibly or obviously affected after prolonged growth of the part in the strict sense of the word. In all the changes of structure which regularly supervene during old age, we see the effects of deterioration or *devolution*, and not of true development.

Thus the child, strictly speaking, does not grow into the man; but the germinal elements of his organs and systems slowly and successively become developed through the period of adolescence, and so eventually form the mature man.[1]

Growth goes on *pari passu* with development; and when development is completed, growth may

[1] Darwin, *Animals and Plants*, vol. ii. p. 404.

still go on to increase bulk, up to a certain point when deterioration begins and increases markedly with the advance of years.

There is also a normal proportional growth for each member, organ, and part of the body.

In order that you may fully appreciate the "immatureness" of a recruit at the age of 18 years, I show you the condition of the bones composing the entire skeleton at this recruiting age compared with those of a full-grown man at 23 to 25 years.

I place before you the separated bones of the skeleton of a lad of just $17\frac{10}{12}$ years of age, *i.e.* within two months of 18 years. Evidence as to age is a difficulty, but this lad was born and brought up in a regiment, and was trained as a drummer, so that his age was known as authentically as the age of a boy in a family can be known. He was sent as an invalid from India, and died in the Invaliding Hospital at Fort Pitt, Chatham, in 1861 ; and there I had the bones of his skeleton prepared as they are now ; and the following woodcuts fairly represent the points which the condition of the bones of the skeleton demonstrates, as to their immaturity.

Another skeleton—a male from 23 to 25 years of age—is shown, to compare with the younger one. In the older skeleton the development of the bones is complete, and their growth nearly complete. They are only incomplete as regards the perfect union of some rims of bone, and in the actual bulk of the bones.

(1) *Bones of the Axial Skeleton—the Cranium, the Spine, Sacrum, Ribs, and Sternum.*

As to the cranium, the basi-occipital and the basi-sphenoidal portions only concern us. The former is united to the latter by intervening cartilage merely, up to the 20th year, after which ossific union begins, and is completed in one or two years.[1]

Commencing with the bones composing the spine (the spinal or vertebral column or backbone), we see them as a number of separate bones superimposed one upon another, which are named "vertebræ" because they can move or turn somewhat upon each other, and being so jointed together as to permit of slight motion between each of them; there is, therefore, a considerable range of movement in the spine as a whole, without much alteration in position between any two of its bones, or any great change in the shape of the column—an arrangement by which great strength is combined with sufficient mobility when the spine is fully grown.[2] The spine, so made up, lies in the middle line of the back of the neck and of the trunk, having the cranium or skull at its summit, the ribs at its sides (which in their turn support the upper limbs), whilst the pelvis, with the lower limbs, is jointed to its lower end. A most perfect piece of mechanism is this central portion of the framework of Nature's masterpiece—the human skeleton.

[1] Quain's *Anatomy*, p. 68, 8th edition.

[2] Humphrey on the *Skeleton*.

In the adult the spine consists of 26 bones, but in a young child it is made up of 33 pieces; so that certain of the bones in the spine of the child have become blended with each other by the time the child reaches the maturity of adult age. Hence it is evident that many changes go on slowly during adolescence towards the complete maturity of these several bones, when they lose some of their mobility as a whole after being so blended together.

The Human Spine is more uniform in length in persons of the same race than might be supposed from the individual differences in stature — the variation in the height of the body in adults being mainly due to differences in the length of the lower limbs. The average length of the spine in man is 28 inches. Its widest part is at the base of the sacrum, from which it tapers down to the tip of the coccyx. It also diminishes in breadth from the base of the sacrum upwards to the region of the neck.[1]

In the adult spine a series of convexo-concave curves are found, which are alternate and mutually dependent. These curves are associated with the erect attitude of man; and in the human spine, above the lumbar vertebræ, form a curve with its convexity forward. "These curves contribute greatly to the elasticity of the vertebral column, which is thus like a bent spring, yielding easily, gradually, and uniformly in all its parts when a weight is placed upon it; and which, in like manner, without any sudden jerk

[1] Turner, *Introduction to Human Anatomy*, p. 16.

assumes its former position when the weight has been removed." [1]

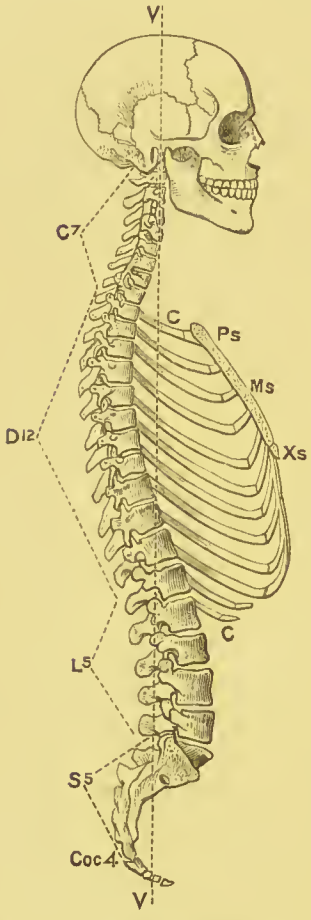

FIG. 1.—The Axial Skeleton. C_7, the cervical vertebræ; D_{12}, the dorsal; L_5, the lumbar; S_5, the sacral; Coc_4, the coccygeal; CC, the series of twelve ribs on one side; Ps, the præ-sternum; Ms, the meso-sternum; Xs, the xiphi-sternum. The dotted line VV represents the vertical axis of the spine.

As the spine forms the central part of the skeleton, it acts as a column to support not only the weight of the body, but of all that can be carried on the head and back, and by the upper limbs; by its transverse and spinous processes it serves also to give attachment to numerous muscles; and the transverse processes of its dorsal vertebræ are also for articulation with the ribs.

The accompanying figure, reproduced from Sir William Turner's introduction to *Human Anatomy*, p. 10, by his permission, conveys the best idea of the component parts of the spinal column, and its relation to the ribs and skull, with its characteristic natural curvatures.

It is further to be noticed that in the living state soft *intervertebral substances* are in-

[1] Humphrey on the *Skeleton*.

serted between the bodies of the several vertebræ, which serve as the bond of union between the component parts of the column, and fill up the gaps between the bodies of the vertebræ that are shown in Fig. 1, p. 78. They are composed of fibrous and fibro-cartilaginous tissue, which is immediately connected with the opposed surfaces of adjacent vertebræ. In the centre of this substance there is a greater quantity of interstitial fluid than in any other part, so that fluid actually forms the chief constituent of the central portion of each, and so constitutes a fluid cushion, or pivot, which supports the middle part of the body of each vertebra. Unequal pressure is thus prevented while the fluid cushion becomes the centre of movement of one vertebra upon another. This central compressed fluid cushion is most marked in the neck and loins, where the movements of the individual bones are most free, and where the opposed surfaces of the bodies of the vertebræ are hollowed out to afford it greater space. These substances "give" a little, and become flattened out under continued pressure of the superincumbent weight of the body during the erect posture, so that a man loses from one-third of an inch to half an inch in height during the day, or as compared with the recumbent position at any time.[1] In advancing

[1] Hence different results as to height are obtained according as a recruit is measured in the erect or in the horizontal position. M. Robert measured 287 soldiers while lying on a graduated bench fitted with footboard and movable headboard. He then measured them in the erect position with the following results :—

years these intervertebral substances become drier, denser, and of a yellowish colour, but they are little liable to disease.

Thus in the construction of the human spine the bones are so shaped and sized, so adjusted in curves, and so arranged with intervening soft, semi-fluid, intervertebral substances, that the required amount of elasticity, strength, and capacity of movement is afforded by the smallest possible quantity and weight of material. We find accordingly as we descend towards the lower parts of the spinal column, and in proportion as the superincumbent weight increases, so do the individual vertebræ gradually become larger, and the intervertebral substances larger and thicker. At the lower part also, where the weight is greatest and the movements are most free, the curve is the shortest as well as the sharpest; that in the neck, where the vertebræ are small (the weight less), and the movements free, the curve is also short; and in the back, where the local movements are very limited and the bones of considerable size, the curve is the longest.[1]

The weakest part of the vertebral column is at the junction of the dorsal with the lumbar portion

Mean height vertically = 65.28 inches = 1.658 metres.
,, ,, horizontally = 65.79 ,, = 1.671 ,,

and the mean difference he estimated at from 1 to 2 centimetres. Inspector-General Dr. Marshall of the British service instituted similar experiments with a resulting difference of about *a quarter* of an inch. The horizontal method has its merits in preventing the recruits practising deception as to their height.—*American Statistics*, *l. c.*, p. 23.

[1] *The Human Skeleton*, Humphrey, p. 152, *et seq.*

(see woodcut of Axial Skeleton, p. 78), including the lower two dorsal and upper two lumbar vertebræ. It is the most concave part of the dorso-lumbar curve; and in the living body forms what is called "the hollow of the back;" and the circumference of the trunk at this part, "the waist," is less than elsewhere. Every now and then we are awakened to a sense of the weakness of this portion of the column by the sudden jar which is felt here on making a false step, or in suddenly and unexpectedly slipping off the pavement.[1] Here also fatigue is felt, especially in prolonged marches and drill; and aching is experienced in the preliminary stages of fever and ague.

Let us now examine the changes which go on very slowly and gradually in the development of these several bones of the spine during adolescence; and in doing so let us mainly confine our attention to the periods which concern the recruit's age—18 to 25. It is not till the period of puberty that the vertebræ gradually attain to nearly their full size and shape;[2] and every one of the individual bones (vertebræ) composing the spinal column in the younger skeleton (at 18 years of age) is imperfect as regards either its development or its growth, or in both of these qualities according to its kind and position in the column.

[1] Humphrey, *l. c.*, p. 170.

[2] Quain's *Anatomy*, 8th edition, edited by Dr. Sharpey, Dr. Allen Thomson, and E. A. Schäfer, p. 20.

The following woodcuts fairly represent the immaturity which the condition of the bones of the younger skeleton demonstrates. At different periods subsequent to puberty, generally about 16th year (Gray),[1] 18th year (Humphrey),[2] five sets of epiphyses (or parts to be added on) commence to grow from separate centres of ossification. Three of these are small portions of bone, placed on the tips of the spinous and transverse processes, 4, 5, and 6, Fig. 2,

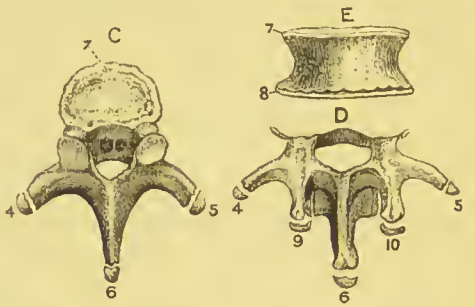

FIG. 2.—C, a dorsal vertebra at about the 11th year, showing epiphyses at the tips of the transverse processes, 4 and 5, and the spinous process, 6, and also 7, the flat *upper* epiphysial plate of the body.

D and E, parts of a lumbar vertebra about the same age showing (in addition to the above) 8, the *lower* epiphysial plate of the body; also 9 and 10, the epiphyses of the mammillary tubercles (ossification of the vertebræ from R. Quain).—Quain's *Anatomy*, 8th edition, p. 29.

C and D; the other two are thin circular plates, one on the upper, 7, C and E, and 8 E; the others on the lower surface of the body, chiefly at its circumference, begin to form about the 18th to the 21st year (Humphrey). In the lumbar vertebræ two other epiphyses surmount the tips of the mammillary processes, 9 and 10 D.

[1] Gray's *Anatomy*, p. 16.

[2] Humphrey, *The Human Skeleton*, p. 122.

These several epiphyses generally appear from the 18th to the 20th year, and are not wholly united to the rest of the vertebræ before the 25th year.[1]

The Sacrum (Fig. 3).—The condition of this bone is of interest at the age of 18 to 20; inasmuch as it is through this strong and expanded bone that the weight of the trunk is immediately transferred to the haunch-bones and to the lower limbs.

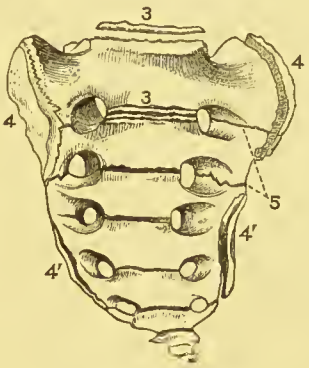

FIG. 3.—The sacrum about the 23d year; 3, 3, epiphysial intervertebral plates still visible above and below the first vertebral body; 5 is at junction of two lines leading to the fissures still remaining between the first and second, and the second and third lateral masses; 4, 4' lateral epiphysial plates (ossification of the sacrum).—R. Quain, *l. c.*, p. 21.

The sacrum in youth presents the elements of five distinct vertebræ, which become one bone in the adult. It is placed below the last lumbar vertebra which rests upon it; and it articulates on each side with the haunch-bones. It is of a wedge shape, as shown in the accompanying figure.

At or about puberty, or about the 16th year, a number of epiphysial plates begin to develop on the bodies of each of the primitive vertebræ composing the sacrum; and two flat irregular plates of bone are eventually added to each lateral surface, the uppermost of which (4, 4, Fig. 3) extends

[1] Quain's *Anatomy*, 8th edition, p. 21.

over the sides of the first two or three; while the lower (4′, 4′) connects the remaining two. These appear from the 18th to the 20th year; and are finally united about the 25th. The bodies of the sacral vertebræ are at first separated by intervertebral plates (3, 3, Fig. 3); but about the *eighteenth* year in the case of the lower vertebræ, ossification begins to extend through these plates and the epiphyses, so as to completely unite their adjacent bodies. The ossific union of the first and second bodies does not take place till the *twenty-fifth* year or later. Previous to this the lateral masses (4, 4, 4′, 4′) have also coalesced nearly in the same order.[1]

At 15 years of age the bodies of the component vertebræ of the sacrum are still separable, the sides being united in an irregular manner, the upper three only slightly, the 3 and 4, and 4 and 5 being imperfectly and irregularly united on opposite sides.[2]

The bodies are for a long time separated by fibro-cartilage, as in other parts of the spine; but soon after puberty they become surrounded and bridged over by bone which grows from the contiguous edges of the bodies. Not till the 25th or 30th year of life are the bodies of the first and second sacral vertebræ completely united, and in some instances they remain separate for life.[3]

[1] Quain, *l. c.*, p. 22.

[2] Humphrey, *l. c.*, p. 450. [3] *Ibid.*, p. 456.

The Ribs.—The next part of the axial skeleton to be examined is the thorax or chest, which is a cavity composed of the sternum in front, the twelve dorsal vertebræ behind, and the twelve ribs with their corresponding cartilages on each side (see Fig. 1, *c*, *c*, p. 78).

The ribs belong to the class of bones which are termed "long bones"—that is, they consist of an elongated shaft or middle portion, and having at one end a head, a neck, and a tubercle. The head is the part which is connected to the side of the body of two adjacent dorsal vertebræ by two articulating surfaces; the neck is the constricted part of the bone which unites the head to the shaft; the tubercle which is close to the junction of the shaft and neck is the part which articulates with the transverse process of the vertebra. They are all alike in the plan of their construction, yet each one differs from the other in certain details, so that each rib, like each particular vertebra, has peculiarities sufficient to distinguish it from the others.

In the very young state of long bones, such as the ribs, and those which compose the arm and the leg, the bone commences to grow in the middle of the shaft and progresses in growth towards either end. The "principal piece" or *shaft* of the bone is thus first formed, and is known to anatomists as the "diaphysis." More or less large portions at either end of this "principal piece" are afterwards superadded; and these remain for variable periods of

time in the *shape* of the bone, but composed of soft cartilaginous growing material, till separate and distinct centres or foci of bony growth appear in them. Eventually, these additional pieces (epiphyses) become wholly converted into bone; and then as bony pieces (or processes as they are technically called), they remain separated for a time (more or less long in different bones) from the "principal piece" or *shaft* by an intervening soft substance, which, for the time being, glues them to the shaft.

FIG. 4.—One of the last true ribs. 1. The "*principal piece*." 2. The thin, bony piece superadded, and known as the "*Epiphysis*" of the "*head*" of the rib. 3. The thin, bony piece superadded, and known as the "*Epiphysis*" of the "*tubercle*" of the rib. The growth of these superadded pieces commences between the 16th and 20th years of life; and they coalesce (or become united by bone) with the principal piece of the rib about the 20th to the 25th year of life.—Quain's *Anatomy*, *l. c.*; also Humphrey on *Skeleton*, p. 334.

This general description applies to all the long bones. There are portions of the ribs where they hinge upon or articulate with the spine, which at the age of 18 years have only commenced to grow from soft material into bone; and these portions are not completely turned into bone till the *twentieth year* of life. The ribs therefore are not mature till that age.

The accompanying woodcut of the last true rib

(Fig. 4) may illustrate what the skeleton demonstrates at the age of 18. The small thin, bony, pieces (2 and 3), which are to be superadded to the "principal piece" or shaft (1) of the rib, ultimately coalesce with it, and are known as the "epiphyses."

The Breast-Bone or Sternum (Fig. 5), which closes in the cavity of the chest in front, is an elongated bone inclining in a downward and forward direction. It consists of three parts in the adult—an upper, called the manubrium or præ-sternum (1, Fig. 5); a middle, the body or meso-sternum (2, 3, and 4, Fig. 5), and a lower, the ensiform or xiphi-sternum (5). The portion (6), which is the top of the ensiform part, is always cartilaginous, and is named the ensiform cartilage. The well-marked transverse lines indicate not only the subdivision of the bone into three parts, but that of the meso-sternum into four originally distinct segments.

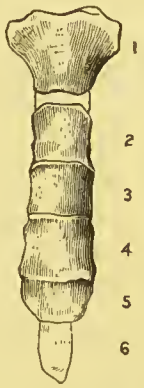

FIG. 5.—The sternum, soon after puberty, showing cartilage between the manubrium (1) and the body; and imperfect union of the first, second, and third pieces of the body (2, 3, and 4); while the third and fourth (4 and 5) are united. The manubrium (1) generally remains separate till after the 25th year; (3) and (4) unite between 20th and 25th.—Quain's *Anatomy*, 8th edition, by Sharpey, Thomson, and Schäfer, vol. i. p. 30.

(2) *Bones of the Shoulder, Arm, Forearm, and Hand.*

Having shown to what extent the component parts of the axial skeleton are immature and in-

complete at the age of 18 years, we have now to examine all the other bones which are symmetrically disposed in connection with it. These are appendages, as it were, to the axial skeleton, consisting of the bones of the upper and lower limbs.

The Upper Limb is made up of the shoulder, upper arm, forearm, and hand.[1] The shoulder is formed by the clavicle and scapula forming together a girdle which connects the appendage-like bones of the upper limb to the axial skeleton. These appendage-like bones are the humerus in the upper arm, the radius and ulna in the forearm, and in the hand the carpal and meta-carpal bones and the phalanges. The clavicle articulates with the upper piece (*manubrium*) of the sternum, while the posterior part of the girdle, the scapula or shoulder-blade, approaches but does not reach the spine behind.

If we examine these bones as to their development and growth at the age of 18 years, it will be seen that the following woodcuts fairly represent the points in which the skeleton at that age demonstrates the conditions of their immaturity.[2]

The Clavicle or Collar-Bone (Fig. 6) extends from the summit of the sternum to the summit of the shoulder, and so connects the upper limb with the trunk in front. It begins to ossify before any other bone in the body for its shaft and shoulder end; but it is not till about the 18th to the 20th

[1] Turner, p. 36.

[2] Quain, *l. c.*, p. 96.

year that a thin epiphysial nucleus appears and begins to grow for the sternal end, which is not united to the shaft till about the *twenty-fifth* year.[1]

FIG. 6.—Clavicle of a man of about 23 years of age; the shaft, 1, fully ossified to the acromial end; the sternal epiphysis, 2.

The Scapula or Shoulder-Blade Bone (Fig. 7) lies at the upper and back part of the chest wall, extending from the second to the seventh rib

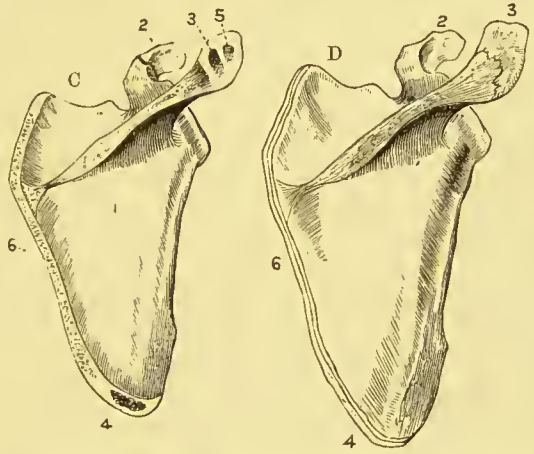

FIG. 7.—C, male scapula about 18th year; a growing centre at 3 having commenced about the 15th to 16th year; a second growing centre, or point of ossification, 5, has appeared in the acromion (or summit of the shoulder); at the base growing bone is also advancing into the epiphysial ridge; also into the epiphysis at the lower angle, 4.

D, the scapula of a man about 22 years of age; the acromion, 3 (or summit), and the ridge, 6, at the base and lower angle, 4, are still separate. This long marginal epiphysis is the last to unite with the rest of the bone. The coracoid or hook-like process, 2, commences to grow from a centre at a year old, and becomes ossified about the 16th year, when it becomes partially united at its base.

behind. Its coracoid or hook-like process, 2, begins to grow in the first year after birth; but it is not

[1] Quain, *l. c.*, p. 96; and Dr. Humphrey, *l. c.*, p. 361.

till the age of puberty that other centres of growth begin, and become united to the body—the lines of union are apparent on the younger skeleton at 18 years of age. The acromion process, 3, is cartilaginous till the 14th to the 16th year, when two distinct nuclei, 3, 5, C, appear. These soon coalesce and form an epiphysis which is united to the spine of the shoulder-blade from the 22d to the 25th year.

FIG. 8.—The bone of the upper arm (Humerus). 1. The "*principal piece*" or shaft. 2. The piece of bone superadded, and known as the "*head*," or upper Epiphysis. It forms a part of the shoulder-joint, and coalesces (or becomes united by bone) with the shaft about the 20th year of life. 3. The lowermost piece superadded, which coalesces before the 18th year. 4. The innermost superadded piece, known as the "*internal condyle*," unites about the 18th year.

The cartilage of the base, 6, becomes the seat of ossification about the 16th to 18th year by the appearance of a line of osseous deposit extending throughout its length. The epiphysis then formed, and the epiphysial lamina, which occasionally forms the border of the articulating cavity of the shoulder-joint, are united to the body about the 25th year.[1]

The Humerus or Bone of the Upper Arm (Fig. 8) is a long bone composed of a shaft and two extremities, the uppermost of which enters into the

[1] Quain, *l. c.*, p. 96.

formation of the shoulder-joint, while the lower extremity enters into the formation of the elbow-joint. The woodcut fairly represents the immaturity of this bone which the skeleton demonstrates at the age of 18 years. The shaft, 1, continues to increase in length till the *twenty-fifth* year of life ; and so long as this growth continues, a portion of soft, vascular, and growing tissue intervenes between the shaft, 1, and head, 2, of the bone. It is not till about the 20th year of life (or not till the 21st)[1] that this soft substance is converted into bone ; and this principal bone of the arm is consolidated.

At the lowermost or elbow end of the bone there are three separate centres from which the development of distinct epiphyses proceeds. The innermost eminence, 4, unites with the shaft, 1, about the 18th year. The other three separate centres coalesce to form one epiphysis, which is united to the shaft in the sixteenth or seventeenth year.

The length of this upper arm-bone is great in proportion to that of the other bones of the upper limb, and it goes on increasing during development and growth. Its relative length is so far a characteristic of the human frame, as compared with the fore-limbs of allied animals. In man they are relatively much shorter, although the whole human body is considerably longer or higher.[2]

The *Radius* (Fig. 9) is the outermost bone of the fore-arm, and like the other long bones consists

[1] Humphrey, *l. c.*, p. 377.

[2] *Ibid.*, p. 89.

of a shaft and two extremities. The upper extremity is the *head*, which has a shallow, smooth

FIG. 9.—The bone of the fore-arm to which the hand is mainly fixed at the wrist-joint (Radius). 1. The principal piece or shaft. 2. The uppermost superadded piece, which coalesces with the shaft about the period of puberty. 3. The lowermost superadded piece, which coalesces with the shaft about the 20th year. 4. Line of separation.

FIG. 10.—The other bone of the fore-arm (the Ulna). 1 The "principal piece" or shaft. 2. The uppermost superadded piece coalesces about the 16th year of age. 3. The lowermost piece next the wrist-joint coalesces about the 20th year. 4. Line of separation.

cup for articulation, with a portion of the humerus in the formation of the elbow-joint.

At the age of 18 the upper epiphysis of the radius is united to the shaft, while the lower epiphysis is still separate.[1]

[1] A peculiar feature in the pathology of the radius is the liability of its lower end to become enlarged in children of strumous habit.

The *ulna* (Fig. 10) is also a long bone, with a large upper end, where it enters largely into the formation of the elbow and the elbow-joint; and the bone generally diminishes in size from above downwards to the wrist.

The upper epiphysis, like that of the radius, is united to the shaft, while the lower one is still separate at the 18th year.

With regard to the bones of the hand, it may be noted that in the meta-carpal bones and phalanges the epiphyses are not united to their respective shafts till about the 20th year.[1]

(3) *Bones of the Haunch or Hip, Thigh, Leg, and Foot.*

These constitute the lower limb, each part having its appropriate bones; and the following woodcuts show the conditions of the immaturity of each bone as seen in the skeleton at or about the 18th year of life.

The *haunch* on each side is composed of a very irregular shaped bone called the "*innominate bone*" (Fig. 11), which enters into the formation of the

The ulna sometimes undergoes the same change. This takes place in no other bones with anything like the same frequency, or to the same extent (Humphrey on the *Skeleton*, p. 385). Hence the persistence of such thickening in a recruit should suggest a careful examination as to other evidences of constitutional tendencies to scrofula or tuberculosis.

[1] Quain, *l. c.*, p. 100.

pelvis, with the sacrum behind, and so transmits the weight of the body to the lower limbs; being the direct medium of connection between the axial skeleton and the thigh, leg, and foot.

The *ilium*, *ischium*, and *pubis*, comprising the *haunch-bone*, are not completely united into a single bone till about the 25th year of life,[1] when their

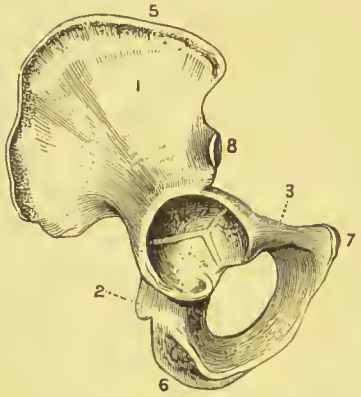

FIG. 11 represents the right innominate bone of a man about the 20th year. In early life it is composed of three bones (1, ilium; 2, ischium; 3, pubis); all of which finally unite at the Y-shaped part in the large cavity (acetabulum), which receives the head of the thigh-bone to form the hip-joint. This special Y-shaped part of union is composed of several fragments of a tri-radiate strip of cartilage, which begin to become bone about the age of puberty; the intermediate bone or epiphysis so formed is united about the 17th or 18th year, and is often united before completion of the hollow for the joint. 5, The epiphysis of the crest of the ilium; 6, that of the tuberosity of the ischium; 7, that of the symphysis pubis; and 8, that of anterior inferior spine of ilium. These are all additional epiphyses which are not yet completely united. Union is not complete till from the 23d to the 25th year.—Quain, p. 118.

completed union is so close that it is not easy to recognise any lines of demarcation.

The *thigh-bone or femur* (Fig. 12) is the longest bone in the skeleton, with its shaft and two extreme ends.

[1] *Introduction to Human Anatomy*, Sir William Turner, p. 45.

The upper end consists of a round, smooth head, 2, set on an elongated neck, which makes a variable angle with the shaft of the bone according to age (and sex) of the individual. The head has also an oval depression in it for the attachment of a very strong, round, inter-articular ligament which unites it to the haunch-bone.

Where the head, 2, unites with the upper end of the shaft 1, there are two processes called trochanters 3 and 3″. The lowermost end, 4, presents a large articular surface, which enters into the formation of the knee-joint.

FIG. 12.—The thigh-bone (Femur). 1, Its "principal piece" or "shaft." 2, The uppermost superadded piece, composing the "head," and forming part of the hip-joint, coalesces with the shaft about the twentieth year of age. 3 and 3″ are pieces superadded, which have joined at an earlier age. 4, The lowermost superadded piece, which takes part in the formation of the knee-joint. The bone is not completed by the coalescence of these parts till after the twentieth year of life; and the lowermost piece at the knee-joint is the last to join.

It is not till shortly after the 20th year of life that the head of the thigh-bone (which forms part of the hip-joint) and the end which forms part of the knee-joint become united to the principal piece or shaft. The small trochanter, 3″, is united about the 17th

year; the great trochanter, 3, about the 18th year; the head, 2, from the 18th to the 19th year; and the lower extremities soon after the 20th year[1]—20 to 25 (Humphrey). The lower epiphysis of the thigh-bone, 4, remains separate longer than that of any other bone of the body.[2]

As to growth, the thigh-bone does not attain its proper length till after puberty. Relatively to the rest of the skeleton, it is longer in man than in most animals, and longer in the European than in the Negro. In cases of rickets it not unfrequently fails to attain its proper length on one or both sides.[3] The connecting medium between the lower epiphysis and the shaft is, not unfrequently, the seat of acute ulcerative inflammation in young persons.

The *tibia or shin-bone* (Fig. 13) is the larger of the two bones of the leg. Upon its upper end the lower end of the thigh-bone rests and transmits through it the weight of the body to the foot. Like other long bones it consists of a shaft and two extremities. It is a bone with three long sides or surfaces, the innermost of which lies immediately under the skin, and is known as the *shin;* and its border forms the sharp ridge of the shin. Its lower end, 4, enters into the formation of the ankle-joint, and forms the inner prominence of the ankle.

Fig. 13 shows the condition as to immaturity of the

[1] Quain, *l. c.*, p. 119.
[2] Humphrey on the *Skeleton*, p. 477.
[3] Humphrey, *l. c.*, pp. 53, 63, 100, and 477.

tibia or shin-bone at from 18 to 20 years of age, the then united condition of the lower epiphysis, 3, which unites between 18th and 19th year; while the uppermost, 2, remains separate, and this upper epiphysis includes the anterior tuberosity. This upper

FIG 13

FIG. 14.

epiphysis and shaft do not unite till 21st or 22d year.

The *fibula or splint-bone* (Fig. 14) is a comparatively slender, long bone, and like the tibia is three-sided. Its upper end or head, 2, articulates with the upper part of the tibia; its lower end,

3, forms the outer prominence of the ankle, and by a smooth surface articulates with the astragalus, to form, with the lower end of the tibia, the ankle-joint.

Fig. 14 shows the condition as to immaturity of the fibula or splint-bone at the age of about the 20th year. While the lower end, 3, is complete about the 21st year, the upper epiphysis, 2, is still

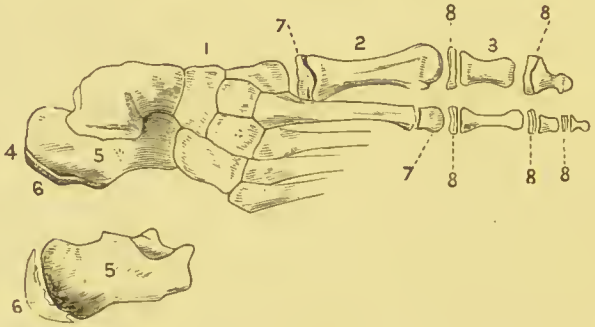

FIG. 15.

separate, and does not unite to the shaft till about the 24th year.[1]

The *Foot*, Fig. 15, is made up of the ankle or *tarsus* composed of seven short and irregularly shaped cube-like bones, 1 ; the bones in front of the ankle-bones (*meta-tarsal*), 2 ; and the phalanges or bones of the toes, 3 ; analogous to those of the hand and fingers, but of much more massive structure. The prominence of the heel, 4, is formed by the projecting posterior surface of the *os calcis*, 5, or heel-bone.

The epiphysis of the heel-bone, 6, is not united

[1] Quain, *l. c.*, p. 122.

to its body or tuberosity till the 20th year of life.[1] The epiphyses of the meta-tarsal bones, 7, do not unite with their shafts till the 18th to the 20th year; and those of the phalanges, 8, to their shafts not till the 19th to the 21st year. This heel-bone is the only one of the short bones[2] except the bodies of the vertebræ (Fig. 2, p. 82), which has a separate epiphysis.

It is thus clearly demonstrated from the extensive observation of the most experienced anatomists, by a study of the bones of the skeleton at different ages, that a great deal of development ("as distinguished from mere growth") goes on in different bones; and tending also to the increase of its bulk by growth, and to the perfection of the human frame up to the age of 25 years; so that the human skeleton cannot be regarded as mature till at least that age. "Ossification is not completed in the different bones until from the 20th to the 25th year."[3]

It also appears that the age at which each bone is complete as to its development is very different with different bones; and in the preceding pages I have mainly noticed only those events in the development and growth of the skeleton which take place between the period of puberty and about from the ages of 18 to 20.

It is also important to notice especially that

[1] Humphrey, *l. c.*, p. 505. [2] Quain, *l. c.*, p. 122.
[3] Sir William Turner, *l. c.*, p. 60.

there are a great many bones (important from their size and position) still very unfinished and immature at the age of 20, which will not be consolidated till several years later.

The breast-bone, for example (Fig. 5), still exists in several separable pieces. The uppermost pieces of the leg-bones are still at 20 years of age separated from their shafts by soft and growing cement. The several pieces of the back-bone (the vertebræ) have also their separate thin plates not yet soldered to their bodies. The bones composing the haunches are still incomplete. They are still surrounded by rims of a soft substance, which, although it becomes bone, does not coalesce with the bodies of the haunch-bones till between the 20th and 25th year of life.

The heel-bones and bones of the toes are also immature at 20.

Generally, also, it may be stated that all these superadded pieces may be separated from the bodies, shafts, or principal pieces of the respective bones by simple maceration in water before coalescence has commenced. The soft cementing substance is thereby decomposed, so that the several pieces fall apart.

Thus the development and growth of the bones are an index to the age of the person ; and although it may be said that this knowledge is of no practical use to the military medical officer in the selection of a recruit, because he cannot take off the flesh from

the bones of the recruit to examine the development of his skeleton, nevertheless, such knowledge is of value and importance because it is based on certain immutable facts in the science of developmental anatomy which cannot be set aside, but must be reckoned with in dealing not merely with the selection of men, but with the training and treatment of them under 25 years of age. And, if possible, it is still more important to be kept in remembrance when we are dealing with the training and military service of lads under 20 years of age ; while it furnishes anatomical and physiological reasons for our belief in the unfitness of lads at and under 18 years of age as soldiers for general service.

The development of the bones of the skeleton observes a distinct and definite order in time as to the beginning of ossification in each bone, and in each piece to be superadded to it. The coalescence of these pieces with each other also follows a definite order as to time in the respective bones which compose the skeleton.

So much indeed is this the rule that, by a careful examination and comparison of the bones of a skeleton one with another at ages before 20 or 25, a skilful anatomist is able to indicate with considerable accuracy the probable age of the individual ; for the period of final coalescence of the several pieces which ultimately compose a bone is very different in different bones, and yet still so very

definite that a knowledge of "events" in the growth of the skeleton during the military age may be of some value to the military medical officer in appreciating the relation between age, development, and growth.

The non-professional reader may pass over the following synopsis of these events:—

TABLE X.—"Events in the Growth of the Bones composing the Human Skeleton during the Military age from 16 to 30 years." Compiled from Records given by Quain, Sharpey, Ellis, Allen, Thomson, Turner, Humphrey, and other accurate Anatomists.

(A. PERIODS OF GROWTH.)

1. FROM THE 16TH TO THE 17TH YEARS.

1. Epiphyses of spines and of the transverse processes of the vertebræ commence.

2. Epiphyses of the articular tuberosities of the lumbar vertebræ commence.

3. The pieces of the sacrum coalesce, commencing with the union of the body of the fourth to that of the fifth piece.

4. Epiphyses of the "heads" and "tubercles" of the ribs ossify.

5. First "centre" in the acromion process of the scapula, or shoulder-blade, begins to ossify.

6. Ossification commences in the lower angle of the scapula.

7. The second "centre" in the acromion process of the scapula grows.

8. The fourth and fifth pieces of the sternum, or breast-bone, begin to coalesce.

9. The epiphysial plate of the heel coalesces with the os calcis, or heel-bone.

10. Coalescence of ilium, ischium, and pubis advances to completion.

11. The crest of the ilium, the tuberosity of the ischium, the pubic ramus, and the anterior inferior spinous process of the pubis begin to ossify.

12. The upper epiphysis of the ulna coalesces with the shaft.

II. FROM THE 17TH TO THE 18TH YEARS.

1. The lateral or auricular pieces of the sacrum grow and coalesce.
2. The styloid process of the temporal bone grows.
3. The base and shoulder-joint pieces (glenoid head) of the scapula are completed.
4. The sternal epiphyses of the clavicle ossify.
5. The lower epiphysis of the humerus unites with the shaft.
6. The epiphysis on the lesser trochanter unites with the shaft of the femur.
7. The epiphyses of the "head" and of the "tubercle" of the ribs commence.
8. Completion of ossification in the lower epiphysis of fibula.

(B. PERIODS OF COALESCENCE AND COMPLETION.)

III. FROM THE 18TH TO THE 20TH YEARS.

1. Completion of the growth of the epiphyses of the "head" and of the "tubercle" of the ribs.
2. Coalescence of the head of the humerus with its shaft.
3. Coalescence of the lower epiphysis of the radius with the shaft.
4. Coalescence of the lower epiphysis of the ulna with its shaft.
5. Coalescence of the epiphyses of the meta-carpal bones with their shafts.
6. Coalescence of the epiphyses of the condyles with the shaft of the femur.
7. Coalescence of the lower epiphysis of the tibia with its shaft.
8. Coalescence of the lower epiphysis of the fibula with its shaft.

IV. FROM THE 20TH TO THE 24TH YEAR.

1. Coalescence of the upper epiphysis of the tibia with its shaft.
2. Coalescence of the upper epiphysis of the fibula with its shaft.
3. The clavicle completes itself.
4. Coalescence of the occipital with the sphenoid bone.
5. Coalescence of the fourth with the third piece of the sternum.
6. Coalescence of the bodies of the vertebræ with their epiphysial plates.
7. The wisdom-teeth appear in the cavity of the mouth.
8. The bones now become gradually thicker, the joints stronger, and the shoulders broader; the muscles firmer, better developed, and more powerful.

V. FROM THE 25TH TO THE 30TH YEAR.

1. Completion of the vertebral column.
2. Completion of the sacrum.
3. Coalescence of the third with the second piece of the sternum, or breast-bone.
4. Completion of the ribs.
5. Coalescence of the haunch-bones with their crests.

After ossification seems complete in the "principal piece," or shaft, a bone still continues to grow in length and to increase in girth, till perfect consolidation of all its portions is complete; and instances are on record which show how a bone may continue to grow "*by irritation*," long after its natural period for growing has gone by.[1] So long as it grows in length, a portion of soft, growing tissue intervenes between the "principal piece" and those parts that are to be completely soldered on. When consolidation is about to take place, the intervening soft tissue, which glues the parts together, is more freely supplied with blood for the purposes of growth; and the hitherto soft substance being converted into bone, the "principal piece" ceases to elongate by growth in that direction. The parts eventually coalesce by permanent bony union, and the bone is consolidated.

From the record of the "events" in the growth of the bones (p. 102), one may judge how long in point of time one end of a bone continues to elongate or grow in length compared with its opposite end.

[1] Paget (Sir James), in description of preparations in Museum of College of Surgeons of England.

Shoulder end after the Elbow end.—Thus the shoulder end of the arm-bone, or humerus, continues to grow towards the shoulder for two years at least after the elbow-joint end of that bone has ceased to grow.

Wrist end after Elbow end.—Again, the wrist-joint ends of the bones of the forearm continue to increase in that direction long after the growth towards the elbow-joint has ceased.

In the lower limbs the relations are the reverse of this. The lower extremity of the thigh-bone continues to grow towards the knee-joint long after the bone has ceased to grow towards the hip-joint; while the upper ends of the principal pieces of the leg-bones continue to grow towards the knee-joint for a considerable time after growth has ceased towards the ankle-joint.

A French physiologist has come to the same conclusions from experiments on animals;[1] and they are results of some importance in connection with excision of joints, and operations on the joints in young subjects.

For instance, excision of the elbow-joint in young persons may not be followed by so decided a shortening of the limb so long as growth continues towards the shoulder and wrist joints, and when the portions removed are only the epiphysial pieces. Excision of the knee-joint, on the contrary, is more often followed by decided shortening of the limb, because at the

[1] M. Ollier, in *Comptes Rendus*, vol. lii., No. 4.

knee-joint growth chiefly advances. For similar reasons excision of the shoulder-joint exposes to more shortening than excision of the hip-joint; and excision of the wrist-joint to more shortening of the arm than removal of the ankle-joint would to that of the leg.

In physiological explanation of this, it may be here noted that, "in the case of the long bones, the epiphysis situated at the end of the bone towards which the canal in the shaft which transmits the nutrient artery is directed, ossifies to the shaft before the epiphysis at the other end. In the humerus or arm-bone, and tibia or shin-bone, and fibula or splint-bone, of the leg, in each of which the canal is directed downwards, the epiphyses at the lower ends of these bones first unite with the shaft; whilst in the femur or thigh-bone, and the radius and ulna of the forearm, in each of which the canal is directed upwards, the ossification first takes place between the upper epiphysis and the shaft." [1]

If we look more closely into the nature of the soft, cementing substance, which decomposes by maceration, and allows the several pieces to fall apart, we shall see that these separate pieces are in a state of very active metamorphosis and growth, and that the soft cementing substance is extremely vascular—almost entirely vascular tissue. And in proportion as ossification advances this vascular tissue diminishes, and the medullary, or central canal, of the principal

[1] Sir William Turner, *l. c.*, p. 60.

piece or shaft of a long bone, becomes more and more hollowed out, while it acquires greater compactness and solidity. The girth of the bone also increases. But what we must most of all bear in mind at this time is, that during all this growth, both in length and in girth, a soft and very vascular tissue, very thin in substance, is in immediate contact with the hard substance of the growing bone, interposed between it and the periosteum. This very thin and soft tissue is mainly composed of fine filaments, holding in its substance a great abundance of germinal particles, and very plentifully supplied with very delicate blood-vessels.

The skeletons show that the portions at either end of the principal pieces of a bone remain for a long time (even after they have become bone) still separated by soft, growing, and very vascular tissue from the principal piece, or shaft, of the bone, and separable by maceration. And, in fact, so long as the shaft, or principal piece, continues to grow in length, the soft vascular tissue, which is the active seat of growth, intervenes between it and the parts which are still to be soldered together. When we find, therefore, that bones are in this separable condition, we know that they are still immature, and unfit for hard exercise or for prolonged marching.

Evidence of the very great vascularity of growing bones is seen in the very numerous openings of various sizes which are crowded together in great

abundance in the vicinity of those parts of bones which are for the time being most actively engaged in growth—namely, the joint-ends of the bones. This is very obvious when we compare the immature skeletons with the finished skeletons at these parts respectively. It is also seen in surgical operations at these parts of growing bones, in which you may have much hæmorrhage from the cut bone in young subjects, as in excision of the joints, or in gouging operations, or in wounds of bone in the joint-ends of the long bones which are still actively engaged in growth. If you examine also this tissue in young animals, it will be seen that blood-vessels extend from the already-formed bone into the soft substance which composes the ends of the principal pieces. And when these soft pieces (already having assumed the shape of bone) are about to ossify, an extended formation of blood-vessels precedes the process of ossification, and a very red zone of blood-vessels appears in that part of the soft cartilaginous ends where bone is about to be formed.

Injuries and diseases of young bones are important because of the ease with which they are produced, and because of the precision as to the periods of the development of bones, and also because the development of osseous tissue is typical.

"Almost all the disease processes observed in bones have their starting-point in the cells of the growing or embryonic medulla, or marrow (that is, in the young cells characteristic of development).

The bones of young persons, or those which in the adult contain fœtal (or embryonic) medulla, as the sternum or vertebræ, are particularly exposed to both nutritive and pathological changes. Different parts of the same bone, however, are not equally subject to the same disease. The most recently-formed—that is to say, the superficial, or sub-periosteal parts, or the bony extremities, particularly when still growing, are those which are the most easily affected. Diseases of the osseous system are, indeed, much more varied and much more frequent than the clinical descriptions of them would lead one to infer. In bones which are growing and in process of development, growth takes place under the periosteum, near the epiphysis, and between the articular cartilages and the bone to which they are applied ;[1] and the physiological activity of those parts is greater during the period of development and growth than in other parts of the bone. In young subjects the epiphyses adjacent to the cartilage of ossification show a condition of physiological congestion. This congestion of the bone is recognised by the red appearance of the marrow ; and to appreciate this change, the normal colour of the marrow, in various bones and at different ages, must be known. The medulla is red, for example, in the sternum (or breast-bone, Fig. 5, 5, p. 87), in the bodies of the vertebræ, and

[1] See Paper by Dr. Alexander Ogston, on "Function of Articular Cartilage," *Journal of Anatomy*, vol. x. p. 49, 1875 ; also vol. xii. p. 503, 1878 (Macmillan & Co.)

in all those parts of bones which are undergoing development. In them morbid (as distinguished from physiological or natural) congestion, more or less simple or complicated, is very easily set up, for the medullary blood-vessels are not supported by a solid framework. Hence hæmorrhages or blood extravasation readily occur in the spongy tissue and medullary parenchyma, and under the periosteum of young and growing bone, as a consequence of slight contusions. This osseous apoplexy is intimately related to general constitutional diseases and cachexiæ, such as scorbutus; and where hæmorrhagic foci are found in the viscera, similar foci are almost always to be found in the epiphyses of bones or inner periosteum." [1]

[1] *Manual of Pathological Histology*, by Cornil and Rauvier, 1886, p. 345, vol. i.

SECTION VI

PROGRESSIVE DEVELOPMENT AND GROWTH OF THE RECRUIT AND YOUNG SOLDIER AS TO HIS HEART, LUNGS, LIVER, SPLEEN, AND KIDNEYS, AND THE IMMATURE CONDITION OF THESE ORGANS AT THE RECRUIT'S AGE OF 18 TO 20.

THE axial part of the skeleton (see Fig. 1, p. 78) formed by the vertebræ, ribs, and sternum is of still more importance for consideration in connection with the development and growth of the vital organs which they enclose and protect. Hence it is necessary to fix attention on the framework of the chest, for the organs contained in this cavity seem most of all to suffer in the recruit and young soldier. It is also necessary to keep in view the fact that, next to the inspiration of bad air, the imperfect or continuously obstructed expansion of the chest tends more than any other cause we know of to bring about diseases of the lungs and heart. The influence of pressure upon the chest in the unfinished condition of its bones and internal organs is therefore of vital importance, and demands our consideration in relation to the training and drill of recruits. "Just as the

twig is bent the tree's inclined." It has been shown that till the 20th year of life the ribs behind are still unfinished, soft at their joint ends, where resistance and motion occur, and where they are still growing. The breast-bone in front is in a similar condition. It is obvious, therefore, that continued pressure upon these parts from before and from behind must exercise a material influence in fixing the future form of the chest. The cartilages of the ribs in front and the breast-bone ought to have full freedom to rise upwards and advance forwards at every inspiration, for thus the diameter of the chest between the front and back is naturally increased at every act of breathing. "Pressure[1] is one of the chief agents in moulding the shape of bones during the developmental processes;" any pressure on the chest, therefore, exerted between the front aspect and the back, when the bones are still growing, must *tend to set* the further growth of the bones in an unnatural direction; for, in order to maintain the vital capacity of the lungs, the capacity of the chest cavity from side to side must come to be increased at the expense of the capacity in the other and normal direction. The capacity of the lungs goes on increasing with age (up to a certain period), and height, and growth, so that men from 5 to 6 feet high inspire from 174 to 262 cubic inches in a progressively ascending scale. The growth of the

1 "Influence of Pressure on the Bones," see Humphrey on the *Human Skeleton*, p. 48.

heart also goes on relatively to the growth of the body. It is not easy to determine at what age the *growth* of the chest may be considered completed. Certain pursuits and occupations, by cultivating the muscles of the breast and back, and the deposition of fat at the approach of middle age, all tend to produce some uncertainty as to the actual size of the thorax. Quetelet has fixed upon the 30th year as the period of its matured growth; and there is a marked increase from 18th to 25th year.[1]

When the prevalence of heart and lung disease, and of aneurisms of the larger blood-vessels in soldiers is considered, the immature condition of the heart, the aorta, and the pulmonary arteries at puberty, and their progressive development and normal growth during adolescence to maturity, becomes of very great importance in correlation with the development and growth of the skeleton framework of the chest in the recruit.

The *heart* furnishes an instance of very great change as regards the relative capacity of its right and left cavities; for, while at birth the capacity of the right cavities compared with those of the left is as one to one and a half, by the age of 50 it is as three to one. Recent observations have further shown that the greatest amount of growth of the heart takes place at from 18 to 25 years of age; so that up to the 25th year of life the heart has not matured its growth.

[1] M. Allaire, *Recueil de Mém. du Med. du Chirurg. Militaires*, 3e series, t. x. p. 161. Paris, 1863.

The importance of Dr. Boyd's observations regarding the progressive growth of the organs in relation to age,[1] and those of Dr. Beneké's[2] on the size of the heart and arteries at various ages, and the great changes which take place in them at puberty, have never received the attention in this country which their importance demands, especially as regards the training of recruits, and the influence of over-exertion during adolescence upon the condition of the heart.

The following Table XI., by Dr. Beneké, shows A, the approximate normal volume of the human heart; and B, its rate of growth.

TABLE XI.—A, APPROXIMATE NORMAL VOLUME OF THE HEART.

No.	Age.	Body-length in centimètres.	Volume of heart in cubic centimètres.	Volume of Heart in cubic centimètres for each 100 centimètres of body-length.	Area of aorta in millimètres.	Area of pulmonary artery in millimètres.
1	0 to 11 days	49 to 52	20 to 25	40 to 50	20	23
2	11 days to 3 months	52 ,, 59	25 ,, 30	46 ,, 54	24	28
3	At end of 1st year	68 ,, 72	40 ,, 45	57 ,, 62	32	36
4	,, 2d ,,	80 ,, 81	48 ,, 54	60 ,, 65	35	39
5	,, 3d ,,	88 ,, 90	56 ,, 62	63 ,, 70	36	40
6	,, 4th ,,	96	66 ,, 72	70 ,, 75	39	41
7	,, 6th ,,	103 ,, 105	78 ,, 84	75 ,, 80	40.5	42.5
8	,, 7th ,,	112	86 ,, 94	78 ,, 84	43	46
9	,, 13th to 14th year	140 ,, 150	120 ,, 140	83 ,, 100	50	52
10	When completely developed	167 ,, 175	215 ,, 290	130 ,, 168	61.5	61
11	Adult age	167 ,, 175	260 ,, 310	150 ,, 190	68	65

1 "Weight of Internal Organs," by Dr. Robert Boyd, *Royal Society Transactions*, February 28, 1861.

2 Beneké, *Der Ueber das Volumen des Herzens und die Weite der Arteria in den verschiedenen Hebensaltem*, 1879.

B, Rate of Growth of the Heart.

No.	Age.	Growth of the heart in cubic centimètres.	Annual growth in cubic centimètres.	Ratio of growth to volume of heart at commencement of corresponding period.
1	0 to 3 months	4 to 5	16 to 20	$\frac{1}{5}$, that is, $\frac{4}{5}$ per annum, or 80 per cent.
2	3 months to 1 year	15 ,, 16	21 ,, 20	$\frac{1}{2}$ to $\frac{2}{3}$, that is, $\frac{2}{3}$ to $\frac{8}{9}$ per ann., or 66 to 88 per cent.
3	In 2d year	8 ,, 9	9 yearly	$\frac{1}{8}$ to $\frac{1}{9}$ per annum, or 20 to 16 per cent.
4	,, 3d ,,	8 ,, 8	,,	,, ,, ,,
5	,, 4th ,,	10 ,, 10	,,	,, ,, ,,
6	In 5th and 6th yr.	12 ,, 12	7 yearly	$\frac{1}{6}$ to $\frac{1}{8}$ per annum, or 16 to 11 per cent.
7	In 7th year	8 ,, 10	,,	,, ,, ,,
8	In 7th to 14th yr.	34 ,, 46	5.6 to 7.6	$\frac{1}{15}$ to $\frac{1}{12}$ per annum, or 7 to 8 per cent.
9	During the development of puberty	95 , 150	19 to 30 when development of puberty takes 5 years	$\frac{1}{6\cdot3}$ to $\frac{1}{4\cdot8}$ per annum, or 16 to 22 per cent.
	,,	,,	47·5 to 75 when it takes 2 years	$\frac{2}{5}$ to $\frac{1}{2}$ per annum, or 40 to 50 per cent.
	,,	,,	95 to 150 when it is complete in 1 year	$\frac{4}{5}$ to 1 per annum, or 80 to 100 per cent.

The volume of the heart is estimated by the number of cubic centimètres of water it displaces.

The growth of the heart during the first year of life is very marked, being about 80 per cent (20 cubic centimètres). In succeeding years, until puberty, it is very considerably less. Between 7 and 14 years of age, the annual increase is only 8 per cent, while during the development of puberty the increase varies between 95 and 100 cubic centimètres—that is, an increase of 80 to 100 per cent. In other words, the heart very nearly or quite doubles in size during the development of puberty. When

the changes of puberty are accomplished rapidly (say in one year), the heart doubles in size during that year; when the changes are spread over two years, the annual growth is 50 per cent; while when over five years, 22 per cent; so that in each case the same change—that is, the doubling of the size—takes place. The enormous importance of the changes to the individual may be inferred from the fact that the heart may in this one year of puberty-development grow three times as much as it did in the preceding.

Generally it may be stated that, while the annual increase, just previous to puberty, is 8 per cent, the additional increase in the heart, when puberty is complete in one year, beyond the increment in the preceding year, is 92 per cent. When the change is prolonged over two years, the excess beyond the average annual growth is 84 per cent, and, when prolonged over five years, 70 per cent; or, in other words, a rapid development of puberty is correlated with a greater cardiac development than is the case when puberty develops slowly.[1]

The following Table XII., compiled from Dr. Boyd's observations, also shows the progressive increase of the heart, as determined by its weight at different ages.

[1] Dr. G. N. Pitt, Physician to Guy's Hospital, *British Medical Journal*, November 1886, p. 1028.

TABLE XII.—WEIGHT OF HEART IN OUNCES, FROM 14 TO 40 YEARS OF AGE (MALE).[1]

	Maximum.	Minimum.	Average.
7 to 14 years . . .	5.5	2.25	4.25
14 to 20 ,, . . .	14.0	3.5	7.61
20 to 30 ,, . . .	17.0	5.5	10.06
30 to 40 ,, . . .	30.25	3.5	11.36

These combined observations of Beneké's and Boyd's show the immaturity of the heart at and before puberty, and the extraordinary task demanded of it when puberty is accomplished rapidly, so that it doubles its size at this period. But it is only in the minority of cases that such a change can take place in one year. Usually this change takes longer, when the growth of the heart is less rapid; and its greatest progressive growth is between the 18th and 25th year.

Clinical experience shows the great demands which at this period are made on the heart,[2] especially in the occurrence of slight cardiac dilatation, and the want of reserve cardiac energy to meet unwonted

[1] Dr. Robert Boyd, *Royal Society's Transactions*, February 28, 1861.

[2] See (1) *On Cardiac Dilatation at Puberty*, by Dr. G. N. Pitt, of Guy's Hospital, *l. c.*; (2) *The Breakdown of Young Soldiers under Training*, by Surgeon-Major F. Arthur Davy, M.D., Woolwich, 1883; (3) Dr. Veale's Paper "On Heart-Disease and Palpitation in the Army" in *Army Medical Department Blue-Book*, 1882; (4) Meyer's Prize Essay "On Diseases of the Heart among Soldiers."

exertion and emergencies, especially in those who have grown rapidly, and are above average height.

The greatest strain is thrown on the heart at puberty and upwards throughout adolescence to adult age ; and a very constant group of symptoms indicates the cardiac failure which must be looked for in overworked recruits. Chief of these is shortness of breath, easily brought on by slight exertion ; the persistence of difficult breathing, and with cardiac discomfort there is sometimes actual pain. The difficulty of breathing may continue throughout the night, so as to prevent rest in the recumbent position for a portion or the whole of the night. Eventually palpitation is set up ; the surest evidence of an overworked and exhausted heart. The patient becomes languid, easily tired, and attacks of partial faintness are easily induced. The cardiac impulse is usually diffused over a larger area, with more or less epigastric pulsation, with prolongation of the first heart sound at the apex, and with accentuation of the second sound over the pulmonary area, while the first sound over aortic area is weaker. The dilatation is usually slight in the first instance ; and the complete disappearance of the symptoms under rational treatment after some time is in accordance with the view that they are due to an insufficiently rapid increase in the size of the heart, which is compensated in a few months, under the influence of sufficient rest and good food.

But when such symptoms occur later in life, they

are usually more serious and less temporary in character; and, not being associated with a physiological developmental process, they do not naturally tend to repair, or to a spontaneously favourable end. That such symptoms occur in adults previously healthy, who have been subjected to much greater exertion than they had been accustomed to or trained to bear, we have the testimony of Drs. Meyer, Veale, Arthur Davy, and G. N. Pitt. Experience further goes to show that the forced "setting up of the chest" in young policemen, recruits, and young soldiers, as well as the military exercises during the autumn manœuvres, and long marches, always contribute a number of such cases, which gradually and completely recover with rest. So also do the games of tennis, football, "hare and hounds," running with beagles, and all such sports or games when they entail over-exertion.

The rational treatment consists of carefully-regulated exercise—always short of fatigue; a rest in the recumbent position for at least two hours in the middle of the day, so as to give the heart an opportunity of recovering its exhausted energies and strength, by the lessening of its work. But such treatment cannot be hurried, and may take a period of six months to complete recovery of cardiac strength. To take a young soldier into hospital for a week or two gives him only temporary ease. As soon as he is sent out to commence his drill again, the same symptoms recur, and it is not till he has *outgrown*

the condition, by maturing his development, that his cure can be completed by the rational treatment that has been indicated.

It is also to be noted that insufficient size of the heart, as a whole, and defective development of its parts may be congenital, and associated with defects of the larger vessels.

"It is not rare for the heart to be abnormally small in proportion to the body weight. It may then be that it was either abnormally small at birth, or that it simply lagged behind the body in its growth. Extreme cases of this condition are rare, but minor degrees are often met with. They are especially associated with conditions of chlorosis and of hæmophilia ; the aorta and other large arteries are usually narrow and thin-walled, while the genital organs, and sometimes the whole body, are ill developed.

"As the growth of the heart is in a measure conditioned by the work it has to do, the increased resistance caused by the narrowness of the aorta may bring about a compensatory or functional hypertrophy of the heart muscle."[1]

At puberty also there is a very marked impetus given to the development of the *lungs*. Their volume increases in conformity with the growth of the skeleton and the expansion of the thorax, or the development and growth of the heart. Their weight also progressively increases, especially from 14

[1] Ziegler, *l. c.*, p. 40.

to 25 years of age, as shown in following Table XIII.—

TABLE XIII.—WEIGHT OF THE LUNGS IN OUNCES, FROM 14 TO 40 YEARS OF AGE (MALE).[1]

	Maximum.		Minimum.		Average.	
	Right.	Left.	Right.	Left.	Right.	Left.
7 to 14 years	16.5	23·5	4·5	4·5	10.14	10.38
14 to 20 ,,	47.0	42.0	7.75	6.5	20.4	19.67
20 to 30 ,,	64.5	58.0	11.0	9.0	32.34	30.09
30 to 40 ,,	87.0	52.0	10.75	10.5	28.47	24.29

During this activity of growth there is also greater determination of blood to the vessels of the lungs—as indicated by the deeper red of their parenchyma (or general substance), and by the liability to pulmonary hæmorrhage (bleeding from the lungs) at that age.

Corresponding activity of function is also indicated by the increased heat-producing power, the energy of muscular motion, and the exaltation of cerebral action.

In the following Table XIV. the progressive growth of (A) the Liver, (B) Spleen, and (C) the Kidneys is shown, between the ages of 14 and 40 years :[2]—

[1] Dr. Boyd, *l. c.*

[2] *Ibid.*

TABLE XIV.

A, Weight of the Liver in Ounces, from 14 to 40 Years of Age (Male).

	Maximum.	Minimum.	Average.
7 to 14 years . . .	71.0	18.25	34.71
14 to 20 ,, . . .	96.0	32.0	57.76
20 to 30 ,, . . .	114.0	32.0	60.29
30 to 40 ,, . . .	101.0	24.5	58.11

B, Weight of the Spleen in Ounces, from 14 to 40 Years of Age (Male).

	Maximum.	Minimum.	Average.
7 to 14 years . . .	5.75	1.0	3.03
14 to 20 ,, . . .	10.75	2.75	5.19
20 to 30 ,, . . .	19.0	2.75	7.19
30 to 40 ,, . . .	36.0	1.75	7.12

C, Weight of the Kidneys in Ounces, from 14 to 40 Years of Age (Male).

	Maximum.	Minimum.	Average.
7 to 14 years . . .	10.5	3.4	6.58
14 to 20 ,, . . .	14.0	5.5	9.34
20 to 30 ,, . . .	16.5	6.0	11.57
30 to 40 ,, . . .	25.0	6.6	11.35

SECTION VII

PROGRESSIVE GROWTH OF BONE AND MUSCLE IN RELATION TO EACH OTHER, AND PROGRESSIVE INCREASE OF STRENGTH WITH AGE, AND THE MINUTE STRUCTURAL ARRANGEMENTS OF BONE

THERE is still another physiological consideration which demands our attention in connection with the *physical growth* of the young soldier,—it is the growth of the bones and muscles in relation to each other, and the minute internal structural arrangement of the material of bone. The skeleton is not merely adapted for locomotion, but its axial portion encloses and defends the important visceral organs, the slow but progressive growth of which has been demonstrated in the preceding pages from the observations of the most competent authorities. The bones are also pillars of support, and they form levers in various attitudes, having, as such, various and important movements. The leverage exercised by such bones may be variously modified: (1) according as the lever is in one or in several pieces, and is more or less complete in the growth of its in-

ternal structure; (2) according as the points, ridges, tuberosities, and prominences for the attachment of the moving muscles and tendons are completely or imperfectly developed and grown.

Accordingly from 20 to 25 the bones become gradually thicker, the joints stronger, the shoulders broader, the muscles firmer and better developed.

When we trace in young animals how this progressive growth is related to the muscles and the bones, we cannot fail to notice that the *development* and *growth* of *the bones* are in adaptation and fitness to the increasing power and actions of the muscles. The bones of the limbs become larger and stronger at their muscular attachments as the muscles become stronger and more active. Not only do the bones adapt themselves in their growth to the growth of the muscles, but if the muscles are paralysed the bones waste as well as the muscles by a progressive wasting, and no amount of passive motion will prevent or retard the occurrence of this atrophy. Again, it has been shown by the accurate experiments of the late James Forbes, while Professor of Natural Philosophy in the University of Edinburgh, that the muscles undergo a gradual, steady, and progressive development in strength as the age of the individual increases from puberty up to 30 years.

From the combined observations of Quetelet and of Forbes, it is known that by exercise of a well-regulated kind, a progressively greater amount of force can be got out of a man as his age increases

(up to a certain period), if his training is judiciously conducted and his bodily condition maintained at the proper standard of health.

Forbes found that—

	Lbs.
Englishmen at the age of 20 to 25 gave a tractile force	366 to 384
Scotchmen at the age of 20 to 25 gave a tractile force	374 to 404
Irishmen at the age of 20 to 25 gave a tractile force	397 to 413

These experiments were made upon upwards of 800 individual students attending Professor Forbes's class in the University of Edinburgh, between the ages of 14 and 25, and they clearly demonstrate the law of physical development correlative with age. Natives of Scotland, England, and Ireland were distinguished. The weights were expressed in pounds, including clothes; the height in inches, including shoes; strength was determined in pounds (as above) by Regnier's dynamometer. Compared with the observations of Quetelet the gradual progress towards maturity in Britain seemed to be greater in the earlier years (14 to 17) than in Belgium, and slower afterwards—a result more strongly indicated also among the English than among the Scotch.

The superior physical development of natives of Britain above the Belgians is very obviously marked. In *strength* it is greatest (one-fifth of the whole); in *height* it is least.

So far as the experiments on the English compared with Irish can be considered as correct, they indicate that the English are the least well developed of the natives of Britain at a given age, while the Irish are the most developed, the Scotch retaining an intermediate place.

The *maximum* height is barely attained at the age of 25; and (what is important for us to note is that) *all the developments were found to increase between fourteen and twenty-six years of age, and all were found to increase more slowly as age increased.*[1]

Moreover, when we come to consider "How a bone is built,"[2] it will be obvious how much stronger must be the finished bone-structure compared with the unfinished structure of the immature bone. Especially will the importance of this mode of looking at the influence of immature compared with mature bone become apparent in regard to those long bones of the leg (and even the shorter long ones of the foot) which have the whole body to support, and on which so much stress is laid in continuous marching or in continuous standing.

The shanks of the long bones in man, in birds, and beasts are tube-like; and the ordinary marrow-bone, as "we find it at the thick end of a leg of mutton, or sticking out from the middle of the round of beef," represents also the structure of the

[1] *Proceedings of Royal Society, Edinburgh*, January 16, 1837.

[2] Dr. Donald MacAlister in *The English Illustrated Magazine* for June 1884 (Macmillan & Co.)

long bones, such as these of the leg in man. In them we may note that—

"First of all, the middle part of the bone is hollow, and its walls are hard and dense; it is in fact a somewhat thick-walled *tube*.

"Secondly, if you follow the bone to either end of it, to a joint, the tube-form seems to be lost; the outer surface spreads into irregular knobs and bosses, the inside instead of being hollow is filled up with a continuous mass of apparently irregular fibres and plates.

"This marrow-bone, which anatomists name the *femur* or thigh-bone (Fig. 12, p. 95), we may take as the type of all marrow-bones, or long bones as they are sometimes called. Long bones have a shank or shaft which is hollow and tube-like, and ends which are—not exactly solid—but continuous or 'spongy' in texture. They are thus distinguished from short bones, which have no hollow shank, but are built up entirely of continuous spongy substance, like the ends of a long bone. We may take the heel-bone or *calcaneum* (Fig. 15, p. 98) as the type of a short bone."

But these "short bones and the ends of the long bones seem to be built on another and different plan. They are not hollow but continuous. Their substance consists of seemingly irregular fibres and plates. The substance has been called 'spongy'; and at first sight it looks a mere confused porous mass. But when pains are taken to cleanse the bone of the shreds of membrane and marrow that fill its pores,

a very remarkable and very beautiful order and regularity takes the place of the confusion. The porous mass might more fitly be likened to a network or a honeycomb than to a sponge. Its plates and bars run straight and clear from point to point, cutting each other in true right angles, and enclosing little square meshes as dainty and as sharply defined as the meshes in some fine piece of lace." This variety of bone substance is said to be *cancellous*.[1]

And as the shanks of the long bones are always built on the plan of the tube, so the pattern of the cancellous parts is also constant, and stands in very definite relation to the shape and purpose of the bone.[2]

The *crushing limit* and the *tearing limit* of bone structure have been shown by Dr. MacAlister in the following table, as compared with cast-steel, wrought-iron, and cast-iron. These materials differ greatly with regard to the relative magnitude of their limits of tenacity.

TABLE XV.—LIMITS OF TENACITY OF BONE COMPARED WITH STEEL AND IRON.

Material.	Tearing limit.	Crushing limit.
Cast-steel	102	145*
Wrought-iron	41	22
Cast-iron	13	73
Bone	9 to 12	13 to 16

* The numbers denote kilogrammes per square millimètre, and refer to average specimens.

[1] *Cancelli* signifying bars or lattice-work.

[2] Dr. MacAlister, *l. c.*

Bone-structure, therefore, comes out well in the comparison. The figures resemble those of steel (though much smaller), and bone-substance is almost as strong to resist tearing as to resist crushing.

But not only is the strength of bone-structure of importance in the building up of a bone, but its strength still further depends on the way in which the material is put together. Upon mechanical principles the round-tube structure of bone is the strongest for support; and its strength mainly lies in its outside, for one "may scoop out the centre of a bone till half its substance has been removed, but still nothing equal to half its strength has been scooped away. We have also an example of the advantage of the tube form in the quill of a feather, in the amount of stiffness and strength which it possesses, so long as its tube form remains intact. In such a shape we have combined the *minimum* of substance with the *maximum* of strength.

"And so the stalks of corn and grasses and plants of all kinds—straws and reeds and canes and bamboos, whatever is remarkable for lightness combined with strength—all are fashioned on the principle of the tube. And in engineering, in building, in mechanism, you will see examples of the principle at every turn. The great Britannia Tubular Bridge that spans a strait of the sea shows it on the largest scale. . . . The back-bones of our bicycles and tricycles are tubes. I have just read of a new tricycle in which not only the back-bone

but all the essential parts are made of hollow steel; and it is described as a miracle of lightness and strength. In making his machine of a material like steel, and in making all its bones hollow tubes, the builder has merely realised in metal the plan on which the human skeleton has been built for some thousands of years."[1]

From an engineering point of view, therefore, Dr. MacAlister has shown that bone is an admirable substance to make tubes of; and the fact that its strength for tension is of the same order as its strength for pressure, allows us to possess bone tubes that are capable of bearing cross-stresses in all directions, and that without any unwieldy massiveness.

The tube-like shank of a long bone, like the thigh-bone (*femur*), is thus not less admirably adapted for its purpose than bone-substance is to be the most admirable material to make it of; so that both as to form and substance it is fashioned after the ideal type of the engineer, so as to yield "the greatest strength with the least material."

But when we come to inquire into the structure of the *ends* of these long bones, we shall see how imperfect is their structure in the immature or young state compared with their structure when mature. The bone in the adult is generally more hollowed out than in the young and growing lad.

In the full-grown and mature bone "the material

[1] Dr. MacAlister, *l. c.*

is massed along the lines where it is of greatest

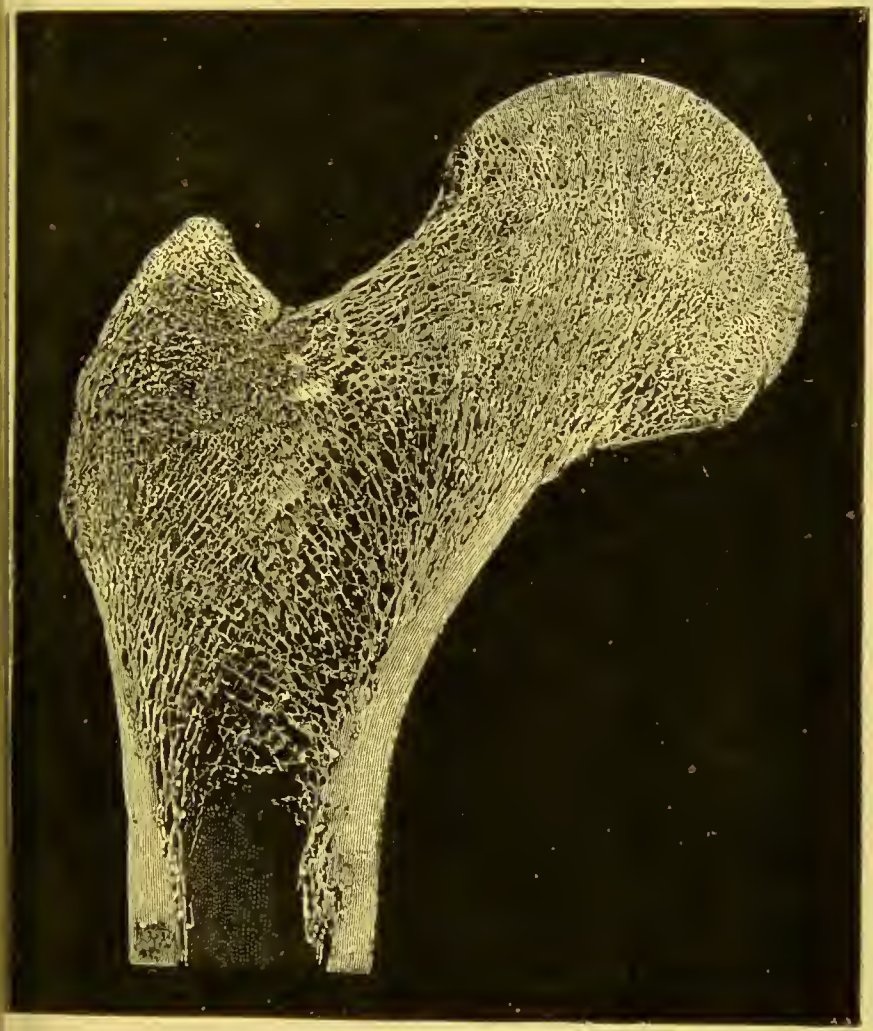

FIG 16.—CANCELLOUS STRUCTURE OF THE HEAD OF THE THIGH-BONE.
From a Photograph by ZAAIJER, *and by permission of* Messrs. MACMILLAN & CO.

service—that is, along the lines where the stresses are greatest, and is withdrawn from the parts where

it would be of less service." This is well shown in the preceding woodcut (Fig. 16), from a photograph by Zaaijer, showing the cancellous structure of the head of the human thigh-bone. Its head is notably expanded, and it curves and overhangs the shaft like the head of a great crane, so much so that by increasing pressure or crushing force the tendency would be rather to "shear" it off; and if we regard its immature condition, as represented in Fig. 12, p. 95, when the epiphyses are still separable from its shaft, and when the lines of its fine internal structure are incomplete at the junction of the epiphyses with the shaft, this tendency must be greatly increased—comparable to a "fault" or "dislocation" in geology—without giving rise to any visible gap or chasm. It is only when the bone is mature or complete as to growth that this crane-like head is perfected, and its lines of fine internal structure are complete and fit to resist the *maximum* of pressure to which it can be put in adult life.

It will further be seen how these "stress-lines" cross each other at right angles—as "pressure-lines" and "tension-lines" do, in any given structure that has to carry weight. They are the lines of *maximum* tension and *maximum* pressure, and when they meet they cut each other at right angles. Along these stress-lines there is no tendency to "shear" when the bone is completely grown; but in the immature bone there is a natural "fault" at the line of junction of the epiphyses which materially

diminishes the pressure-bearing strength of the bone.

Let us consider now the section of the heel-bone (Fig. 17) or calcaneum. It is a short bone, composed entirely of *cancelli*, and is roughly triangular with three bearing surfaces.

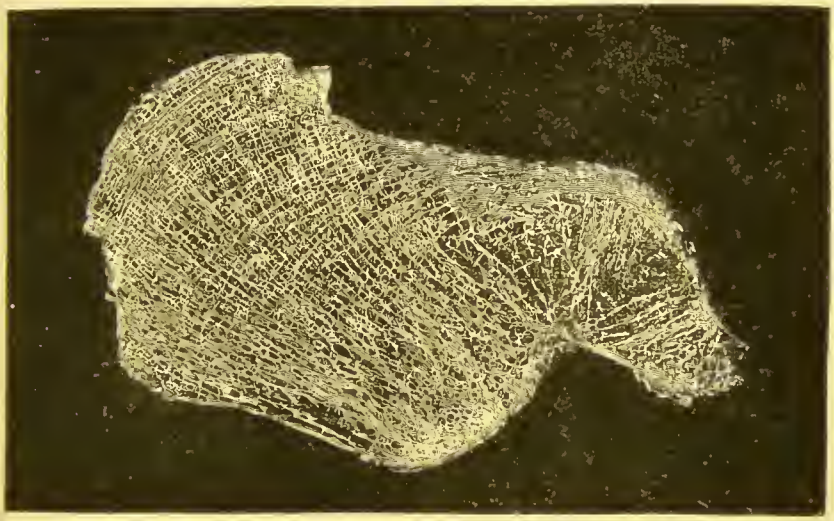

FIG. 17.—CANCELLOUS STRUCTURE OF THE HEEL-BONE.

From a Photograph by ZAAIJER, *and by permission of* Messrs. MACMILLAN & CO.

The *uppermost surface* receives the weight of the body from the ankle-joint. This surface is therefore subject to intense downward pressure, and therefore "stress-lines" are seen to start from it.

The *under surface* rests on the ground, and is pressed upon by the ground, and therefore "stress-pressure-lines" spring from this lower surface, and

run upwards to meet those coming down from the ankle-joint.

The *anterior bearing surface* is in contact with the bones of the arch of the foot, and transmits the pressure forwards to them from the ankle by a second system of pressure-lines running obliquely forwards, while there are strong tension-lines forming a cross-tie system linking the lower ends of these lines together, like "the cross-tie of a rafter, or the rope which joins the lower end of the ladder and the prop in an ordinary pair of steps." And as Dr. MacAlister observes: "In the photographed section of the heel-bone you cannot fail to be struck with the beautiful way in which the bars of the lattice-work run in the lines which theory requires. The tension-lines especially are developed in singular perfection. You see how densely they are massed at the under surface where the tendency to tear the bone asunder is the greatest; and how they rise diverging like the lines of a fan, backward to the surface of attachment of the great tendon of Achilles through which the calf-muscles act, and forward to the anterior part to meet the short anterior pressure-lines. Everywhere the meshes formed by the crossing-lines are rectangular—in itself a proof that the lines are true stress-lines."

When we compare this mature heel-bone with the condition of the immature one figured at p. 98, (Fig. 15, 5), it will be seen where the stress-lines are deficient from the interval between the body

of the bone and the epiphysis to which the tendo-Achillis is attached.

The accompanying woodcut (Fig. 18)[1] is a diagram showing some of the "stress-lines" in the arch of the human foot in its complete and mature condition, from a drawing by Professor Hermann Meyer. The diagram is not strictly a section, and the stress-lines are not all in one plane. The heel-

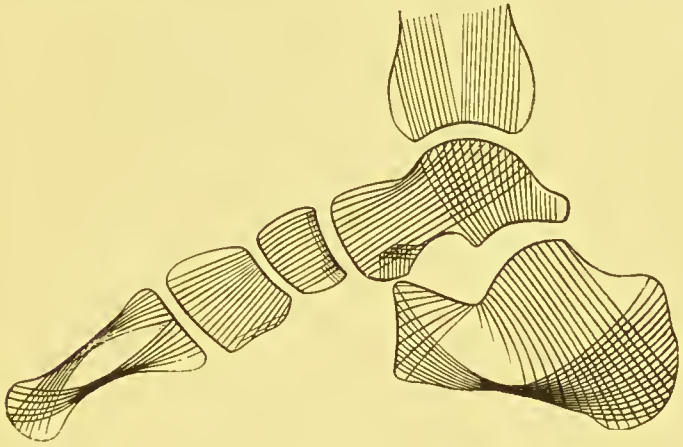

FIG. 18.

bone is below to the right, the ankle-bone is above it, and the leg-bone highest of all. It is intended to be contrasted with the immature human foot (Fig. 15) at p. 98, rendering evident the imperfections of the young and growing bones, when their epiphyses are still separate, especially as to the deficient continuity of the stress-lines.

The imperfections and comparative weakness of the immature thigh-bone, when its epiphysial head

[1] Here reproduced by permission of Messrs. Macmillan & Co.

has not yet united to the shaft, must be still more obvious when the mature thigh-bone is studied as to its structural resemblance to an overhanging crane.

Dr. MacAlister gives the following woodcut [1] (Fig. 19) of the stress-lines in the head of a crane, from a design by Professor Culman, compared with the stress-

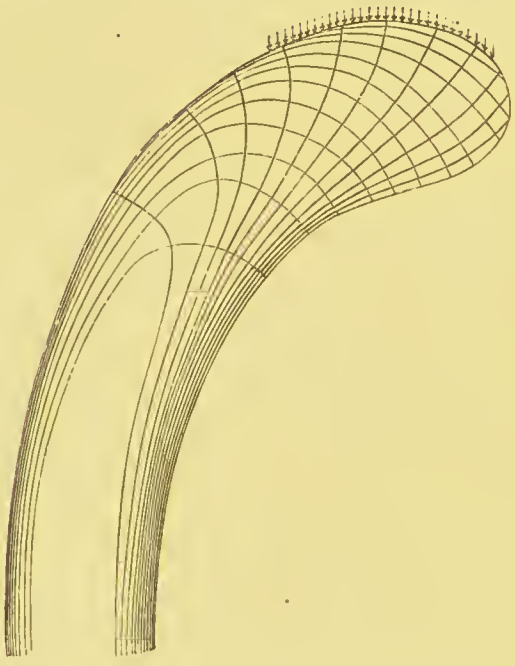

FIG. 19.

lines in the head of a mature thigh-bone, from a drawing by Dr. Julius Wolff (Fig. 20). The weight-bearing head of the bone is to the right; the great trochanter is to the left. It is a careful drawing of the cancelli of the head of the thigh-bone, from a study of thin sections of its substance. "The form of the head is

[1] Reproduced by permission of Messrs. Macmillan & Co.

less simple than that of the crane; but everywhere the ideal principles of construction are beautifully illustrated. The strong pressure-lines descending from the chief weight-bearing surface to the inner border of the shaft; the overarching tension-lines

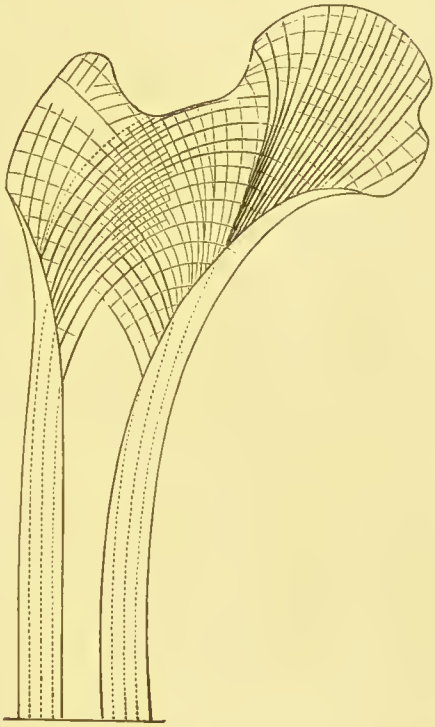

FIG. 20.

rising from the outer border and lifting up the overhanging head; the secondary set of pressure-lines springing from the concave border and going to sustain the second protuberance (technically called the *great trochanter*), with its secondary loading—the central hollow of the shaft, the square-meshed

lattice-work of the cancellous ends—all are shown and all become vivid with meaning. What the scientific engineer conceives—but with present tools and present material cannot yet embody—has been exquisitely embodied in the structure of a common marrow-bone ever since bones came into fashion."[1]

These anatomical facts and the mechanical principles which they embody cannot fail to render obvious how imperfect as to physiological strength is the minute internal structural arrangement of the substance of the bones of the skeleton in the recruit and young soldier during adolescence as contrasted with the full-grown adult skeleton.

[1] *Macmillan's Illustrated Magazine*, *l. c.*, p. 149.

SECTION VIII

SELECTION OF THE RECRUIT, ESPECIALLY WITH REFERENCE TO "THE PHYSICAL EQUIVALENTS" WHICH MAY INDICATE HIS AGE; AND ON THE PRINCIPLES WHICH OUGHT TO REGULATE HIS TRAINING

FROM the suggestive facts and observations recorded in the previous sections, you will readily understand why it is that the topic which challenges our attention at the very threshold of entrance into medico-military life concerns the ages and the physical condition of the men with whom the medical officer will have to deal—the material, or "human stuff," in fact, which he has to select in the first instance, to care for and to preserve as efficient soldiers throughout the period of their service, however long or short.

This duty, namely "*The Selection of Recruits*," is one which has of late years engaged a very large share of attention on the part of the Government and the community generally, both in and out of Parliament, and that not only in this but in other countries. It is a duty of the greatest importance

considered either from a military, a medical, or a social point of view, and it has become of special and increasing importance in connection with the short-service system of enlistment in this country as explained in previous pages.

From your medical training you will readily appreciate the position I endeavour to take up and insist upon here—namely, that the physical condition of the recruit must be judged of by the standards of physiological and developmental anatomy, and that the correlation of his physical condition with age is especially of importance, because any immatureness of the framework of the young soldier, or of his internal organs, or any deficiency of stamina in his constitution, will be sure to furnish sources of difficulty in his subsequent career. His immaturity of development and growth, or other physical deficiencies, will assuredly find him out. The severe drill-training and the hardships of military service through which he must pass are certain to bring his weaker points to the test sooner or later, and sooner rather than later. Indeed, "the survival of the fittest" in "the struggle for existence" is perhaps nowhere better exemplified than in the rank and file of military service. Hence the physical conditions I have referred to—namely, immatureness, want of stamina or staying-power, *i.e.* power of endurance in the constitution of the young soldier—have a most important bearing upon the causes of some of those diseases, the pathology of which we shall consider in detail as

opportunities present themselves. At an age so young as 18 years, a height much *below the average* for *that* age,—65.5 to 68 inches,—and still more at the *minimum* of 55 to 59 inches, is apt to have been the result of defective feeding in early life, tending to a diminution in the normal rate of increase and growth of the body. Under such circumstances stunted development and diseased vital processes are the inevitable consequences. The constitutional tendencies in the future of the "growing lad" are thus more or less fixed at an early age; and although at the age of 18 the recruit may have no evident disease, yet anything below an *average*, and, still more, a *minimum* height and weight for that age, suggests a tendency to constitutional disease which requires to be very carefully inquired into.

On the other hand, as the height approaches a *maximum* at the age of 18 years, the excess of growth of the body generally (compared with the imperfect growth of the heart and great vessels, and the imperfect expansion, growth, and vital capacity of the chest and lungs) becomes very obvious by the contrast of the tall body with the narrow and flat chest in which the apices of the lungs approach close to each other. Generally in such cases the reparative organs are out of proportion to the body they have to sustain.[1] They are immature and not yet sufficiently developed in correlation with height.

[1] Dr. E. Smith on *Cyclical Changes of the Human Constitution* p. 288.

In the selection of recruits, therefore, the duty of the medical examining officer embraces, in the first instance, the capacity of determining ages from, say, 17 to 25 and upwards, and, next, the capability for inquiring into those mere external or physiognomical characters of the individual which furnish the grounds for believing that he is sound and free from disease, or the contrary. Both these duties require that details of positive facts shall be carefully noted in order to determine the physical peculiarities of the individual, and such "physical equivalents" as may (1) justify conclusions as to his age and (2) those peculiarities, the sum of which mark his *temperament*, *i.e.* the original vital endowments of the individual, "unquestionably a real force, which we would gladly recognise and estimate if we could." [1]

It is by long experience and varied observation of men that we are able "to judge the interiors by the outside," and so acquire a *physiognomical* intuitive knowledge of them (Sir T. Browne); and it is only by such ripened experience that we come to know gradually "the real value of common and obvious, still more of uncommon and not obvious facts, *when seen in combination*, so as to form conjointly a basis for larger inferences." [2]

A distinct proclivity to disease implies a "diathesis" or particular habit of body predisposing to

[1] Jonathan Hutchinson, *The Pedigree of Disease*, p. 22, London, 1884.

[2] Professor W. T. Gairdner, M. D., in Findlayson's *Clinical Medicine*, 1886.

certain diseases rather than to others, the evidence of which is based on a careful study of the physical structure of the individual body, and of those incidents in its life-history which tell of, or which actually leave traces or even visible and indelible marks of the previous existence of disease. To investigate diathesis in an individual is therefore to study facts in his life-history which indicate the previous existence of deranged physiological functions, or manifest structural changes, from which we are able to establish the existence of a *continued tendency* to similar changes, or to changes of an allied order in the future.[1]

There is, for example, a whole group of diseases which affect the human body chiefly or exclusively during its period of growth, whether of early infancy or adolescence, with both of which you have to do. "Certain transverse markings on the teeth (distinct in character from the syphilitic), curvatures, or other alterations in the long bones and thickenings of joint-ends of bones, and a certain well-known conformation of the thorax, may indicate with the utmost precision that disorders proper to the period of the first or second dentition had existed when rickety distortion, with or without bronchitis, and other severe but not permanent conditions of disease interfering with the due expansion of the lungs, may have thus far left an impress on the bony skeleton.

"So, too, the presence or absence of the traces of past disease of the bones and joints, or of

[1] Dr. W. T. Gairdner, *l. c.*, p. 6.

glandular enlargements and cicatrices in the neck, or of spinal disease or curvature, may, together with a certain conformation of the chest, or indeed of the body generally, form part of a chain of circumstantial evidence tending to prove or to disprove a liability to tubercular disease of the lungs." [1]

We come now to consider "the physical equivalents" by which age may be determined.

In the enlistment of lads and men whose ages are unknown, it is necessary that we should be possessed of a mean standard of *height*, *weight*, and *chest-girth* at the various ages eligible for military service. Such mean standards in their correlation constitute "the physical equivalents" of age, by which the medical officers are mainly guided in their selection of individuals.

But, looking to the various conditions on which we ought to rely in passing recruits, it is obvious that we cannot depend on these "physical equivalents" alone. There must be evidence, in addition, (1) of sufficient stamina; (2) of freedom from disease in the growing lad—for the rate of development and growth varies so much that it gives ample scope for selection, above and below the mean *height*, *weight*, and *chest-girth*, for the requirements of the different arms of the service. So that, even at the age of 17 or 18 years, the "physical equivalents" may be so good and so fully expressed that rejection ought not to be thought of.

[1] Dr. W. T. Gairdner, *l. c.*, p. 4.

Therefore it is that immaturity and unfitness, or, on the other hand, matureness and staying-power in a recruit, must be inquired into from several points of view, but especially as regards his development and growth in relation to age; and especially as regards the correlation of *height*, *weight*, *chest-girth*, *chest-expansion*, and *chest-capacity*, or "pulmonary play," with age.

It is in the due concurrence of these factors in physical development and growth in relation to age that we must look for the evidences of greatest perfection in a recruit. Such due concurrence constitutes the best evidence we yet possess of normal and healthy physical development and growth. Conversely, a want of due concurrence as regards these factors is sure to be associated with evidences of immaturity and imperfections; so that any great divergence from the average of these factors in relation to age most probably indicates that some physical incapacity exists which will render the individual unfit for military service. It is the duty of the medical officer to find out the correlation or want of correlation of these factors, seeing that the final rejection of the recruit is left for his professional decision.

Hence it is necessary at the outset to obtain data for comparison in the form of "*physical equivalents*" for each year of life during the military age; by which the medical officer may determine the age of the individual. We are required to determine

what are the proper or *average* standards of *height*, *weight*, and *chest-girth*, or *chest-capacity* at the various ages at which lads and young men are eligible for enlistment. These constitute the "physical equivalents of age" by which the military medical officer is to be guided in fixing the age of the recruit. But these standards imply a further knowledge as to the developmental proportions and growth of the human body at and before the military age for enlistment, so that the data from this combined knowledge may come to be exponents which furnish not only the "*physical equivalents*" of the age of the recruit, but they ought to foreshadow what may be his condition at manhood when growth is complete.

In regard to the correlation of these factors, one specially important point ought to be determined, in the first instance—namely, the period of *full growth of the individual*, as regards the country, and even the district, whence recruits are drawn; because it is of importance in its relation to "*the mean stature of the full-grown man.*" It is unquestionably established that *height* continues to increase very measurably up to the *twenty-fifth* year; but the full growth of the body as a whole cannot be regarded as complete till considerably later. The white native of the Northern States of America does not attain his *full growth* till between 30 and 35 years of age. Mr. Gould's tables indicate the *thirty-first* to the *thirty-fourth* year as the time when *growth* is complete; but the age of completed *growth* seems

to vary considerably in different countries and nationalities. In France it is variously given as from the 23d to the 35th year.[1] In Belgium Quetelet decided for the 30th year for full height, the increase of growth after 25 being slight but regular; in Switzerland M. Dunant for the 26th year. Liharzik in Vienna, and in England Danson and Boyd regard the 25th year as the year of matured growth. Dr. Beddoe selects the 23d year, though he admits a slight increase after that age—the mean age being over 25 years.[2]

The preponderance of evidence from developmental anatomy is that physical development is completed by the 23d to the 25th year in this country; but that *growth* or bulk as a whole may not be complete till at least the 30th year.

"A comparison of national stature, in which the data should be obtained by measuring only men who had reached the age of completed growth, is much to be desired; and if in addition these men were taken promiscuously from the general population the result would be most satisfactory;" while the systematic measuring of the cadaver, as opportunities offer, by modern anatomists would still further conduce to the necessary conditions for comparison. The American statistics furnish valuable material in this direction. Men belonging to the six nationalities represented in the following Table XVI. have been

[1] *American Statistics*, *l. c.*, p. 18.
[2] *Medical Statistics*, *l. c.*, p. 18.

carefully separated, and their mean height determined when at an age *not under* 30 nor *over* 35 years, or at the period of their fully completed growth. A comparison of the result with the mean stature of the race at all ages from 18 to 45 is here given.

TABLE XVI.—A COMPARISON OF THE MEAN STATURE AT THE PERIOD OF COMPLETED GROWTH, WITH THE MEAN STATURE AT ALL AGES FROM 18 TO 45 YEARS, GIVES THE FOLLOWING RESULTS :—

Nationality.	Mean height at full growth, age 30 to 35.	Mean height at all ages, from 18 to 45.
	Inches. Metres.	Inches. Metres.
United States, Whites.	68.22 = 1.7328	67.69 = 1.7193
British America . .	67.65 = 1.7183	67.14 = 1.7054
United States, Coloured	67.22 = 1.7074	66.66 = 1.6932
England . . .	66.92 = 1.6908	66.59 = 1.6913
Ireland . . .	66.91 = 1.6995	66.75 = 1.6953
Germany . . .	66.67 = 1.6934	66.53 = 1.6899

The importance of a knowledge of the period of attainment of full growth, and of the *mean* natural or standard height, is shown by the experience of M. Champouillon in 1868, during his examination of men for the *Garde Nationale Mobile*, when he had to re-examine those who had been exempted in 1864, 1865, and 1866. He found that of 100 men rejected in 1864 as below the standard, 71

had attained the requisite height in 1868. Of those in 1865 he found *fifty-five* men ; and of those in 1866 *forty-five* men, who had likewise become of competent height in 1865. These men at the period of exemption as below the *minimum* limit of height were *twenty* years of age.[1]

The mean height of an army does not necessarily show the mean height of the people whence the recruits are drawn.

As a physiological fact man does not reach the maturity of his functions and the complete growth as to bulk of his skeleton till between the ages of 25 and 30 years ; and the amount or degree of maturity varies with each individual at any given age up till that time of life. The skeleton, however, seems to reach its limits of development very nearly at the same time as the whole frame reaches its *maximum* of height, the coalescence of the various epiphyses being pretty well completed about the 23d to the 25th year, while the muscular system in its increase tallies with the weight of the whole body.

Mr. Charles Roberts of St. George's Hospital, London, has tabulated an immense mass of statistics of *height*, *weight*, *chest-girth*, and *strength*, which have been collected by the Anthropometric Committee of the Statistical Society. He comes to the conclusion that the increase between 25 and 30 is not due to growth, but that the apparent increase is due to the

[1] *American Statistics*, *l. c.*, p. 21.

elimination by disease and death of the smaller and feebler members of the community in increasing numbers as age advances; that we must therefore place a mortality table by the side of our statistics of the living if we are to understand their due significance.

He is of opinion that it is impossible to determine the exact period of maturity in man by measurements of several *different* persons; and this question can only be set at rest by *following the growth of the same individual* from year to year until it ceases; and judging from observations, Dr. Charles Roberts believes that very little growth in height takes place after the age of 21; that it entirely ceases before 25 years of age; that the age of 23, fixed by Dr. Beddoe (of Clifton) many years ago, may safely be accepted as the age of full growth (as to height) of man in this country; and that all things being equal, to possess good physical proportions in relation to age is the best guarantee of a healthy body.

The selection of recruits to be judicious implies, therefore, a regard to the due concurrence of *age*, *height*, *weight*, and *chest-girth*, *chest expansion and capacity*, as an index of their development, and as the basis of selection, while their future treatment in training and drill must be regulated accordingly. The earlier the age fixed upon as the *minimum* at which recruits may be taken, the longer will the period of probation necessary for careful and efficient training

require to be; for the practical outcome of the facts and arguments I have brought together is, that recruits ought not to be allowed to leave this country as soldiers in the ranks under 20 years of age, as a *minimum*, for obvious physiological reasons; and that 18 should be fixed as a *minimum* age for the acceptance of recruits for training only, and not for general duty; that the training should extend over the two years from 18 to 20, to the exclusion of all arduous military duty; that the trainers of the lads and the officers commanding during that period should have at least an elementary knowledge of the anatomy and physiology of man;[1] that in the primary selection of recruits we ought practically to know: the *averages* or *means*, and the *maxima* and *minima* of the *height*, *weight*, and *chest-girth* at the several ages from 17 to 25 or 30; and this not only of the inhabitants of this country generally, but also those of the particular districts whence recruits are drawn for enlistment at the depot centres.

Such records would give an extensive basis for determining what ought to be the safest "physical equivalents of age," while the education and experience of the medical officer would enable him finally

[1] For this purpose, Sheets V. and VI. of *Johnston's Illustrations of Natural Philosophy*, with handbook to the illustrations by Sir William Turner, M.B. London, Professor of Anatomy in the University of Edinburgh, should be made a study of by every trainer of recruits and young soldiers. The cost is less than £1 (W. & A. K. Johnston, Easter Road, Edinburgh).

to determine how far above or below the mean it might be safe to accept any individual recruit.

Besides helping towards an estimation of age, the "*physical equivalents*" furnish material to determine at the *minimum* limit of age of a recruit, whether or not there are evidences of sufficient physique in the growing lad to carry him through the shortest period for which he can be enlisted, without the risk of his breaking down and becoming a burden to the service or to his parish.

As to Training.—The anatomical data and physiological principles which have been set forth in the preceding pages obviously culminate in the following general conclusions as to what ought to be the method of training recruits.

If the object of training is (as it ought to be) to put the body, with extreme and exceptional care, under the influence of all the agents which promote its health and strength in order to enable it to meet extreme and exceptional demands upon its energies, too much care cannot be taken in the selection of recruits.[1] It is obvious also that the exaction of extreme energy from young and growing lads should be long delayed and very gradually exerted, because of the pernicious influence of extreme exertion upon the most susceptible and vital organs of the body, which are still immature, especially the heart and lungs, which cannot fail to affect subsequent health

[1] *Training in Theory and Practice*, by Archibald Maclaren, 1876.

and strength. Drill and training ought therefore to be extended over a lengthened period of time, proportioned to the state of individual development and of bodily power.

Why is it that a young recruit, so far as wind is concerned, cannot keep pace with a full-grown man already in the ranks and in complete training? It is mainly because his heart and lungs, arteries and veins, are not yet fully developed; and also because they have not been trained for the exceptional exercise of "drill." They have grown on, and have been fashioned under entirely other circumstances and other occupations, which enabled them to perform their functions in quite another manner than that which, as a soldier in completest training, they are called upon to do. They have grown up with results on the functional powers of these organs as distinctly and as surely inevitable as those which have fashioned the hands for the work of the artist, craftsman, or labourer.

In the drill of the young recruit, the heart (still immature) may be called upon to contract at the rate of 110 or more times in a minute, while hitherto it had been left in circumstances which regulated its growth and determined its power so as to contract at the normal rate of 75 times in a minute. The new occupation of military drill must (more or less) slowly refashion these organs to the work that is required of them. A new heart and new lungs have to be called into being, suitable for the work

they have to do. This must take time. Such changes can only be effected very gradually, bit by bit, atom by atom.

Training must, therefore, be rationally carried out in its initiatory details, or it will certainly fail in its expected results, with the usual damage to the constitution of the soldier. Failure usually arises from the attempt to do too much at the outset. In the training of horses, the points always attended to are the very gradual increase of the exercise and the pace. Gentle walking is persevered in for a long time, then gallops; then, as the horse gains wind and strength, quicker gallops; but the horse is never distressed; and a boy would be dismissed from a stable if it were known that the horse he was riding showed by sighing or in any other way that the speed was too great for him.[1] So ought it to be with the young recruit and his drill sergeant. No change in the human body can be accomplished suddenly; and the agencies by which changes are to be effected must be applied very gradually, slowly, and regularly. The recruit must be trained *within* his powers of endurance at the first start, his work being only gradually augmented in energy and in sustained activity—such as "at the double." The throb of the heart and the swell of the arteries and veins must be allowed to subside and settle down completely, so that his lungs may resume their

[1] *Practical Hygiene*, by Dr. E. A. Parkes, edited by Professor De Chaumont.

peaceful action of easy breathing before any further drill exertion is attempted.

If, while training, the recruit is properly fed (and that is a cardinal point in judicious training), he ought to gain and not lose in weight in proportion to the progress of his development and growth. If, on the other hand, a recruit continues progressively to lose in weight under judiciously regulated exercise and training, he becomes a fit subject for medical inquiry, and possibly for rejection as "never likely to become an efficient soldier."

SECTION IX

METHODS WHICH HAVE BEEN ADOPTED FOR DETERMINING "PHYSICAL EQUIVALENTS" IN RELATION TO AGE; AND INFLUENCE OF CERTAIN MODIFYING AGENCIES UPON DEVELOPMENT AND GROWTH

WITH these objects in view let us consider the *methods* which have been employed to determine the proportions of the human body, and especially such "physical equivalents" in relation to age as may serve for fixing standards for comparing individuals as to fitness or unfitness for military service.

The proportions of the human body have been studied much more by artists and sculptors from the earliest times than by anatomists and physiologists; but with the result in common that certain typical forms are found to prevail through all stages of development around which irregularities as to *height*, *weight*, *chest-girth*, and *chest-expansion*, and *capacity* group themselves in a more or less uniform manner, and so help to guide us towards the determination of typical or *mean* results as the "*physical equivalents*" of age. Hence it is that the masterpieces of

ancient and modern sculpture furnish us with an ideal of a sound and perfectly organised bodily structure—at the various ages of life—an ideal relation of size and form, as between every separate part; and that every outward and inward structure contributes an exactly balanced proportion to the whole visible result.[1]

To the æsthetic mind of Sir Joshua Reynolds we owe the idea in this country of a typical form existing in man; but he furnishes no tables of dimensions from actual measurements. It was the late M. Quetelet, the famous Belgian astronomer and statistician, who eventually reduced the artistic conceptions of Sir Joshua to a scientific generalisation, based on the binomial theorem of Newton and Pascal; and his theory has now been tested by the observations and experiments of scientific men in all the civilised countries of the world. In 1871 he published his book on *Anthropometry*, and in it he demonstrates the power of the calculus of probabilities, upon certain data, to exhibit the mean of man's physical and intellectual faculties; and amongst other things he treats of the mean results of measurements and their relations to the laws of growth. He discerned that there was symmetry in divergence and law for disagreement from type; and discarding all theories founded on arbitrary units of measurements, M. Quetelet reasoned that if a typical figure or model of the human race

[1] Dr. W. T. Gairdner, *l. c.*, p. 13.

existed, all variations from it in excess or in defect would be due to accidental causes; that these divergencies would be found in corresponding groups, and that by applying the theory of probabilities to the problem the number in each varying group could be approximately predicted. Another consequence of the theory was that the more numerous the observations the more effectually would the accidental causes counteract each other, and leave the general type in more prominent relief. The groups nearest to the *mean* would be the most numerous, and the receding groups on either side would diminish in number with the distance. These groups follow numerically a law which can be laid down in advance—the law familiar to mathematicians as the law of the coefficients of the binomial; and in the case of man it has been applied by M. Quetelet not only to the *height* of man, but to the proportions of his limbs, his *weight*, his *chest-girth*, and to all the faculties or qualities of his body that can be reduced to figures. Thus he obtains and recognises the existence of a typical or *mean* form in man, "*l'homme moyen*," the *mean* (not average) man, as a result of a very large number of actual measurements. In this way Quetelet demonstrated that the human race admits of a type or model being determined, the different proportions of which can be stated. Now we especially desire to know, in relation to recruiting, what are the variations or departures from the model or mean man as regards race, or the *average*

man as regards the country or district whence recruits are drawn as to *height, weight, chest-girth, expansion, and capacity* of the body in relation to age? This knowledge can only be arrived at from a large number of observations of individuals. Those who come nearest the mean are the most numerous, those who deviate the most from it above and below furnish the fewest numbers in the groups. It will also be seen that a *mean* basis for selection having been determined for lads and full-grown men, the *rate* of development and growth varies so much that it gives ample scope for the selection of men with a view to the special requirements of certain arms of the service.[1]

[1] *Mean and Average.*—The distinction between a *mean* and an *average* is often overlooked. Sir John Herschel clearly exhibits it in the following passage: "The distinction is one of much importance, and is properly insisted on by M. Quetelet, who proposes to use the word *mean* only for the former, and to speak of the latter (average) as the 'arithmetical mean.' We prefer the term average not only because both are truly arithmetical means, but because the latter term carries with it that vitiated and vulgar association which renders it less fit for exact and philosophical use. An average may exist of the most different objects, as of the heights of houses in a town, or the sizes of books in a library. It may be convenient to convey a general notion of the things averaged, but an *average* involves no conception of *a natural and recognisable central magnitude, all differences from which ought to be regarded as deviations from a standard.* The notion of a *mean*, on the other hand, does imply such a conception, standing distinguished from an average by this very feature—namely, the regular march of the groups, increasing to a *maximum* and then diminishing. An average gives us no assurance that the future will be like the past. A *mean* may be reckoned on with the most implicit confidence. All the philosophical value of statistical results depends on a due appreciation of this distinction and acceptance of its consequences."—*Edinburgh Review*, No. clxxxv., July 1850, vol. xcii. p. 1.

The conclusions arrived at by the most eminent investigators in this branch of science may be stated as follows :[1]—

(1) There is a perfect form or type of man ; and the tendency of the race is to attain this type.

(2) The order of growth is regular towards this type.

(3) The variations from this type follow a definite law—the law of accidental causes ; and the line formed by these variations gives the binomial curve.

(4) The more numerous the data obtained by actual measurements, supposing them to be made with reasonable care and without bias, the more nearly accurate is the mean result ; and the more closely does it correspond with that obtained by calculation.

The physique of recruits on enlistment must always be a matter of great importance ; and their physical qualifications will now be considered under the heads of *age*, *height*, *weight*, *and chest-measurements*. The tables in illustration are the outcome, in the first instance, of the advance of sanitary science in recent years. They especially arose out of the various inquiries of Parliamentary Committees, which, from time to time, have sat preliminary to the legislative enactments embodied in the Factory Acts, mainly brought about by the late Lord Shaftes-

[1] *Statistics Medical and Anthropological of Provost-Marshal General's Bureau*, p. lxxxiii., by J. H. Baxter, A.M., M.D., Washington, 1875.

bury. Numerous statistics are also to be found in the various Parliamentary Reports on those Acts, and in the Journal of the Statistical Society, and more especially in the valuable Papers contributed by Charles Roberts, Esq., F.R.C.S., in the pages of St. George's Hospital Reports, which he has subsequently expanded and made more complete in his work on *Anthropometry*.[1] These statistics have also been utilised in the Reports of the British Association in relation to *Anthropometry*.

But by far the most extensive records of actual measurements are those which have issued from the Bureau of the Provost-Marshal-General, derived from the records of the examinations for military service in the armies of the United States during the war of the Rebellion. These records cover the examinations of over a million of men, furnishing data vastly exceeding in extent any of a similar nature ever before collected and published.

But in relation to recruits for the British service I would rather adopt the results obtained by Mr. Roberts's measurements, inasmuch as they refer to the population of this country whence our recruits are drawn. These statistics of Mr. Roberts further distinguish and recognise the influence of a very important modifying agency upon physique, inasmuch as he gives separate results for the *non-labouring* or *more favoured classes*, as distinguished

[1] *A Manual of Anthropometry*, by Charles Roberts, F.R.C.S., London, 1878.

from the *labouring* or *industrial and artisan population* among men. Labour and abstention from labour are thus recognisable as important modifying agents, which markedly influence the "physical equivalents" in relation to age.

The more recent Annual Reports on Recruiting show that there is often considerable difficulty in obtaining recruits who are quite up to some of the standards of height and chest-girth required by the military authorities, especially for the Guards and Artillery; and it seems very desirable that these standards should be compared with the general population, and their values determined, and if necessary, revised from time to time.

While the ideal physique of the normal and healthy man should always be before the mind's eye of the recruiting officer, we ought not to delude ourselves with mere fanciful notions as to what the ideal physique of an army ought to be (especially as to any extreme height of a soldier, without reference to other measurements), but rather content ourselves with *what an army is capable of becoming:* (1) by the careful selection of the material at our command; and (2) by the best modes of dealing with that material, especially in the judicious training and proper feeding of recruits after enlistment.

"Owing to the age of the recruit having been raised to the physical equivalent of 19 years (and again, in 1885, reduced to 18), there are undoubtedly a very large number of promising young

men, of young men who are likely to make effective soldiers, rejected at a time of life when their inclinations lead them to follow the army, and it is more than probable that after rejection they seek other employment or emigrate, and are lost to the service.

"On inquiry from the recruiting districts it is found that 600 men were actually recorded as having been medically rejected during 1882 between 18 and 19 years of age, who, though not physically equivalent to 19 would otherwise have made efficient soldiers."[1]

The physical qualifications required for enlistment into the army have varied from time to time, and it has been the practice to raise or lower the standard according to the lesser or greater number of recruits required. See Appendix I. for the present conditions of enlistment.

On this point the Inspector-General of Recruiting observes that "the expediency of making these very frequent alterations in the standard is very doubtful. It must be admitted that the conditions and terms that are offered in the recruiting market should be as simple and permanent as possible; when the *minimum* standard is fixed at which a man is considered likely to make a good soldier, there seems to be no reason why it should be changed. If a man of a given physique is fit to be

[1] *Report on Recruiting* for 1882, of date March 1, 1883, by Major-General Sir E. Bulwer.

taken as a recruit at one time, he will, under the same conditions, be fit at another time. Should the supply become greater than the demand, it would be better to limit the selection by making more stringent inquiries as to a recruit's antecedents, and by increasing the facilities for transfer to the Reserve.

"At present the medical officer is required to record his opinion as to the correctness of the recruit's apparent age, and the recruiter is responsible for inquiries as to his antecedents, and that the recruit is what he represents himself to be; but in view of the complaints that have arisen as to incorrect age given on attestation, and as to fraudulent enlistment, it may be desirable at some future time to demand, when any doubt arises about a man on these points, a certificate as to age and a guarantee that the recruit's answers to the questions put to him as to former service are correct."

A definite age as a requirement in a recruit has always been a difficulty in selecting him: (1) as to how the age is to be determined; and (2) as to the question of fitness (or rather unfitness) for fighting and general service as an efficient soldier under 21 years of age.

Of these difficulties in their order, and as they concern the army medical officer: As to determining age, on him is now cast this responsibility, and difficulties arise in this way. Hitherto soldiers have not been entitled to reckon service under 18 years of age as a claim for pension. Consequently

recruits have had at once an inducement to state that they are 18 years of age when they are not, in order to secure enlistment. This is a well-established fact, quite in accordance with human nature under the circumstances.

Provided, therefore, that a young lad has attained to the *minimum* height authorised by the military authorities as the *stature* at which he may be enlisted—if he is seen to be what has been termed "a growing lad," however young he may be, the recruiting officer rejoices to get him. This term, "growing lad," is used, in fact, to characterise the article advertised for, when recruits are in demand; and the recruiting officer will enlist recruits when they are even under the required stature in certain exigencies of the service. Hence it comes about that boys are quite ready to say they are 18, and men of 30 to 40 are not less ready to swear they are under 25. Thus it comes to pass that at the very outset the military medical officer has to contend with deception as regards age; and in these respects recruits sometimes succeed in deceiving the most experienced medical and military officials.

The medical officer can only form his own opinion, to the best of his judgment, as to the age of the individual recruit; and this is what he is now required to do as a definite duty. On the authority of a *Report on Recruiting*, dated January 1, 1878, we are told that, in a large number of cases, there is no doubt that recruits on enlist-

ment have overstated their real age, and consequently that a number of immature lads have been enrolled in the army. In order to check this serious evil instructions have been issued to the medical examining officers to decide according to the best of their judgment what is the age of the recruit, as tested not only by height and chest-measurement, but also by weight; and, I would add, by an examination of the mouth and teeth and jaws.

The act of attestation now makes a recruit a soldier. All inquiries, therefore, as to the fitness of a recruit morally and physically must, if possible, be made before his attestation.

But it has been felt that "the final approval of a recruit for the service is, as far as concerns his physical qualifications, more a medical than a military question. *The onus of rejection on these grounds has therefore been transferred from the shoulders of the approving field officers to those of the medical officers of the army;* and all cases of appeal or differences of opinion after a recruit has been finally medically approved and attested are referred to headquarters for decision. This decision is arrived at on the advice of the Director-General, Army Medical Department, who recommends whether the recruit shall be rejected, retained, or brought before a Medical Board.

"In order to obviate as far as possible any differences of opinion between the Civil Medical Practitioners and the officers of the Army Medical

Department, it was necessary to ensure that there should be uniformity in the method of testing a recruit."

The regulations of the Army Medical Department on this point are set forth in detail in the *Regulations for the Medical Department of Her Majesty's Army*, 1885, Section II., p. 168 *et seq.*[1]

With regard to age, therefore, the authorities have decided that, except in the case of boys, the "physical equivalents" of 17 to 18 years for "growing lads," and 18 to 25 years of age for men, will in future be the *minimum* for enlistment for all branches in the service; and while the *minimum* in height of infantry is reduced to 5 feet 4 inches, the tables which follow show the "physical equivalents" as regards the elementary conditions, which ought to enter into comparison with each other—namely, *height*, *weight*, *girth of chest*, *expansion of chest and capacity*, in relation to age.

In our army it is sometimes deemed desirable to have recruits of a particular age—such as 20, for example, for some arms of the service; for others, 18 to 19 is the more useful age. Cavalry men, for instance, are better taught to ride at 18 than at 20; and, generally, it may be said, that a recruit enlisted

[1] See also a paper by Sir Thomas Crawford in the *Army Medical Reports* for 1862, dated 1864. Professor Sir Thomas Longmore uses in the Army Medical School a set form of examination (*Instructions on the Examination of Recruits*, Southampton, 1882), which renders it almost impossible that any point can be overlooked; also, *Remarks on the Examination of Recruits*, by H. H. Massy, 8vo, London, 1854.

at 18 and trained to 20, is better than a recruit taken off the streets at 20.

Such was the opinion expressed by Mr. Hardy (now Viscount Cranbrook) in moving the Army Estimates in 1876, when Secretary of State for War.[1]

We have also his authority for stating that it takes *one year to a year and a half* to train a recruit before he is fit for general service; and if his training be judicious (as he justly observes), then his development and constitution are improved by it.

But at one time the standard of physical requirements was outside the bounds of healthy physiological limits. Thus a chest circumference of only 33 inches in a man 5 feet 8 inches, and 25 years of age, represents a very slight frame; and in a lad of the same height, and only 18 years of age, the correlations of his *physical equivalents* would suggest grave doubts as to the future capabilities of such a recruit. At present it may be said that the requirements are within fairly reasonable limits; except that the ideas of relationship between "growing lads" and (so called) men at 18 to 25 are somewhat confused. (See Appendix I.)

According to the Reports of the Inspector-General of Recruiting, "Adverse criticism is confined generally to the youth and smallness of the men. The age at which it is necessary to take recruits, while so many men are wanted, is an age at which some men look younger and some older than they

[1] *The Times*, March 3, 1876.

are. The medical officers are instructed to take care that all men are physically equivalent to their ages, *i.e.* 17 to 18, and 18 to 25. These officers may sometimes be deceived in giving their judgment, and they may occasionally pass men into the service who have a much greater physical equivalent than that of their actual age; but, on the other hand, the appearance of recruits is often deceptive, many of them who are actually 18, and possessed of the physical equivalents of that age, having the appearance of youths of 17, or even less"—probably due to the influence of insufficient food in early life.

The Inspector-General further reports that "the year in which the greatest number of recruits was raised was 1876. In that year the *minimum* chest-measurement was 33 inches, and the *minimum* age was 18.[1] Since that time, in addition to raising the *minimum* standard of age and chest-measurement, other precautions have been adopted to prevent ineligible men from being passed into the service. The medical officers are now made solely responsible for the physique. The sergeants are now paid and dependent for the continuance of their employment upon their conduct. A form of inquiry has been instituted to check fraudulent enlistment; and all recruits are under medical supervision for three months after joining, and therefore are practically on probation. Under these circumstances, and

[1] Now, 1886-87, the *minimum* standard for men (? lads) is again reduced to 18 years of age and 33 inches of chest-girth.

considering the fact that in some districts it has been reported that many men are sent away who exhibit all the promise of becoming efficient soldiers, it is well worthy of consideration whether more latitude cannot be given to commanding officers and medical officers of districts, in allowing them to pass into the service men under the *minimum* standard, both as to age and chest-measurement, who have every appearance of making good and efficient soldiers. Both the commanding officers and medical officers are officers of standing and experience, and ought to be worthy of the trust."[1]

The following tables, while they illustrate the method of procedure for obtaining the *mean* results referred to, give the data required for the "*physical equivalents*" in relation to ages.

Mr. Charles Roberts's original tables[2] of the two classes of the English population are examples of the methods of treating anthropometrical statistics; and they may be accepted as the highest standard of our English race. The measurements are of—

(1) Lads and men living under the most favourable conditions of breeding, nurture, occupation, climate, exercise, and sanitary surroundings: persons of rank and outdoor professions; from large public schools, Woolwich Academy and Sandhurst College, Oxford and Cambridge Universities, and St. George's Hospital.

[1] *Report* for 1885, dated 1886, by Major-General Sir E. Bulwer.
[2] Roberts, *A Manual of Anthropometry*, London, 1878.

(2) Lads and men living under less favourable sanitary conditions and occupations, who may be accepted as a standard of the physique of the English labouring population generally, living in large towns; the measurements of artisans and working men of the labouring population.

The tables embrace only the military ages, from 17 to 30, and the height being the most characteristic and important measurement of the body, its arrangement is made the model for the rest. As the height is taken from the ground, and increases with the age of the individual till full growth is reached, the table is constructed to read from below upwards; the smaller values being placed at the bottom, and the larger ones at the top—an order the reverse of that usually adopted in statistical tables. In this way the tables of heights follow the natural order of the developments of the body, from the age of 18 up to completed development and growth. In order to obtain an adequate idea of the variations in the size of different individuals of the same age, and the limits *above* and *below* the *average* and *means* to which these variations extend, the whole number of observations is given. The averages are worked out from the original measurements, and not from the *per mille* groups, by dividing the sums of the various observations by the number of observations. As the number of observations for each age is not the same, the whole of them are reduced to a uniform rate per 1000, for the purpose of comparing one year of life with another.

In the two final tables the *averages*, and not the *means*, are given, inasmuch as they are intended to show the variations in the height, weight, and chest-girth of different classes of the British community, whence recruits are drawn, as distinguished by averages, which are "the numerical expressions of *probabilities*; the extreme values expressing *possibilities*." [1]

Means are used when it is desired to distinguish the specific characteristics of different races of mankind.

The following Table XVII. illustrates M. Quetelet's and Mr. Roberts's method, as explained in the previous pages :—

TABLE XVII.—HEIGHTS (FROM ACTUAL MEASUREMENT) OF 430 ENGLISH PUBLIC SCHOOL BOYS OF THE AGE FROM 11 TO 12 YEARS

	Height in inches.	Number of boys in each group.	
	60	3 .	Giant boys.
	59	4	
	58	12	
	57	22	
	56	36	
	55	54	
	54	79	
Typical	. . .	. . .	Typical or mean boy.
	53	78	
	52	59	
	51	35	
	50	29	
	49	12	
	48	4	
	47	3 .	Dwarf boys.

[1] Dr. Guy, *Cyclop. Anat. and Phys.*, Art. "Statistics."

It will be seen that the numbers arrange themselves according to a very uniform rule—the most numerous groups are in the middle of the column, at 53 and 54 inches, while the groups at 52 and 55 inches are less in number, and those at 51 and 56 inches are still fewer; and so on till the extremely small numbers of the very short and very tall boys of 47 and 60 inches respectively are reached. By this method of grouping the boys, it is ascertained that the *mean* or *typical* boy of the class and age given is 53.5 inches; and, as representing the most numerous group, he forms the standard from which the other groups of boys decrease in number as they depart further and further from his proportions. Hence, if a boy has to be chosen at the age of 11 to 12, the nearer he comes to $53\frac{1}{2}$ inches as to height the better; for the more natural and normal will be his physical condition for that age. Conversely, 53.5 inches in height would be the "*physical equivalent*" for the age from 11 to 12 years, so far as height is concerned in relation to age.

It will also be observed, if the numbers are counted, that there are 10 more boys *below* the *mean* than *above* it; consequently, the *average* (obtained by dividing the sum of the values observed by the number of observations) is here lower than the *mean*. It is therefore necessary, in dealing with large numbers, to keep in view the difference between a *mean* and an *average*, as already explained in note, p. 159. Thus the regular march of the groups,

increasing to a *maximum*, and then again diminishing, recognises a natural and recognisable central magnitude ; all differences from which ought to be regarded as deviations from a standard. Mere averages are of no use in determining physical qualities, because an average conveys to the mind no definite idea of the great variableness of the individuals from which it has been deduced.

The method, therefore, to follow in such kind of inquiry, is to accumulate a large number of individual measurements for each age (as has been done in the following tables), and arrange the results in groups accordingly, so as to determine the range and nature of deviations from types (of height and weight, for example), and so find out the *modifying influences* which produce the deviations. It is the "*modifying influences*" which the medical officer has to consider, because the physical equivalents obtained by this method will represent the equilibrium of many contending forces, or factors, in the conditions of life and nutrition, which may be disturbed by the subsequent predominance of some disqualifying agency.

It is, then, the variations of the individuals as to their "*physical equivalents*" *above* and *below* the average which are significant of the agencies at work in modifying the development of the body. For example, the typical "*physical equivalents*" are not the same for the *working man* and the NON-*working man*; for the man or boy living in the town and the man or boy living in the country. This point has not

been taken into consideration in framing the table which was given as a guide in 1882 for the selection of recruits.

Each group (in the table) above and below the mean is typical of the predominance of some modifying cause, or factor, influencing the rate of growth—if we could but find it out. Many such modifying causes are obscure and very complicated; others are easily recognised; and all are deserving of careful investigation. We know that there are certain permanent and constant elements which modify the development of the human body. These are especially, *age*, *sex*, *race*; and there are others which are secondary and temporary, such as *disease*, *occupation*, *social habits* and *surroundings*, *nutrition*, *food*, *labour*, *exercise*, *rest*, and perhaps many others.

The numbers in the following tables are selected because, while they extend over the most important years of life for us, namely, the military age from 17 to 30, they comprehend those phases of life where the development of the body and physical equivalents in relation to age are most subject to modifying influences.

Height.

The Tables XVIII. and XIX. relate to heights absolute (without shoes), and they are seen to vary according to the social circumstances of the individuals—non-labouring (Table XVIII.) and labouring (Table XIX.)

TABLE XVIII.—Actual, Average, and Mean Heights, and Annual Rate of Growth, at Ages between and inclusive of 17 and 30 Years, of the Most Favoured, *i.e.* Non-Labouring Classes. From Charles Roberts, F.R.C.S., *Manual of Anthropometry*, pp. 72, 73.

Age last birthday		17	18	19	20	21	22	23	24	25 to 30	Age last birthday	
No. of observations at each age		1602	1522	794	391	340	205	91	45	70	No. of observations at each age	
Height without shoes											Height without shoes	
From ft. in.	From inches										inches	metres
6 5	77 to 78	..	1	1	..	..		..	..	..	77.5	1.969
6 4	76 to 77	1	1	..	2	..	..	..	..	..	76.5	1.944
6 3	75 to 76	2	2	3	7	..	4	..	..	..	75.5	1.918
6 2	74 to 75	2	4	10	10	12	6	11	..	14	74.5	1.893
6 1	73 to 74	5	19	25	25	33	10	33	22	14	73.5	1.868
6 0	72 to 73	25	34	62	79	50	53	44	44	43	72.5	1.841
5 11	71 to 72	72	73	68	94	89	78	77	111	114	71.5	1.816
5 10	70 to 71	98	124	116	135	165	146	142	133	214	70.5	1.791
5 9	69 to 70	124	136	186	184	133	137	132	134	144	69.5	1.765
5 8	68 to 69	158	167	164	148	148	157	133	267	143	68.5	1.740
5 7	67 to 68	150	142	124	115	142	142	121	133	143	67.5	1.714
5 6	66 to 67	139	122	109	86	133	146	120	67	86	66.5	1.689
5 5	65 to 66	95	69	62	61	59	49	100	45	43	65.5	1.664
5 4	64 to 65	64	54	38	38	24	35	87	44	28	64.5	1.638
5 3	63 to 64	49	39	20	10	9	34	..	..	14	63.5	1.613
5 2	62 to 63	14	7	6	..	3	4	..	..	..	62.5	1.587
5 1	61 to 62	5	4	5	..	..	..	..	..	..	61.5	1.562
5 0	60 to 61	2	1	1	..	..	..	..	..	..	60.5	1.537
4 11	59 to 60	1	1	..	..	..	..	..	..	..	59.5	1.511
4 10	58 to 59	..	..	..	..	..	..	..	..	..	58.5	1.486
4 9	57 to 58	..	..	..	..	..	..	..	..	..	57.5	1.460
4 8	56 to 57	1	..	..	..	..	..	..	..	..	56.5	1.435
Total . .		1000	1000	1000	1000	1000	1000	1000	1000	1000	Total	
Average height .		67.86	68.29	68.72	69.13	69.16	68.93	68.52	68.95	69.06	Average height	
Average growth .		1.46	0.43	0.43	0.41	0.03	..	..	..	..	Average growth	
Mean height .		68.00	68.50	68.75	69.00	69.00	69.00	69.00	69.00	69.00	Mean height	
Mean growth .		1.50	0.50	0.25	0.25	..	..	..	..	..	Mean growth	
Age last birthday		17	18	19	20	21	22	23	24	25 to 50	Age last birthday	

TABLE XIX.—Actual, Average, and Mean Heights, and Annual Rate of Growth of Lads between and inclusive of Ages 17 to 50 of the Artisan or Labouring, *i.e.* Least Favoured Class in English Population. From Charles Roberts, F.R.C.S., *Manual of Anthropometry*, p. 81.

Age last birthday		17	18	19	20	21 to 22	23 to 50				Age last birthday	
No. of observations at each age		453	153	97	69	91	135	156	1117	318	No. of observations at each age	
Height without shoes.											Average	
From ft. in.	From inches										inches	metres
6 0	72 to 73	..	..	..	..	..	7	6			72.5	1.841
5 11	71 to 72	2	6	31	14	44	7	7			71.5	1.816
5 10	70 to 71	6	33	21	29	33	52	45			70.5	1.791
5 9	69 to 70	16	33	62	44	44	99	89			69.5	1.765
5 8	68 to 69	40	72	82	116	77	148	160			68.5	1.740
5 7	67 to 68	62	80	113	174	121	126	128			67.5	1.715
5 6	66 to 67	106	184	144	246	308	163	161			66.5	1.689
5 5	65 to 66	155	139	216	116	197	156	154			65.5	1.664
5 4	64 to 65	182	184	155	87	99	163	160			64.5	1.638
5 3	63 to 64	170	157	93	73	55	22	26			63.5	1.613
5 2	62 to 63	122	72	42	101	22	30	32			62.5	1.587
5 1	61 to 62	81	20	41	..	..	29	26			61.5	1.562
5 0	60 to 61	15	13	..	..	..	..	6			60.5	1.537
4 11	59 to 60	28	6	..	..	..	..	..			59.5	1.511
4 10	58 to 59	11	..	..	..	..	..	..			58.5	1.486
4 9	57 to 58	..	..	..	..	..	..	..			57.5	1.460
4 8	56 to 57	4	..	..	..	..	..	..			56.5	1.435
4 7	55 to 56	..	2	..	..	..	..	..			55.5	1.410
Total . .		1000	1000	1000	1000	1000	1000	..	1117	318	Total	
Average height .		64.45	65.47	66.02	66.31	66.60	66.68	66.65	66.39	66.72	Average height	
Average growth .		1.52	1.02	0.55	0.29	0.29	0.08	..	..	..	Average growth	
Mean height .		64.5	65.5	66.0	66.25	66.5	..	66.5	..	..	Mean height	
Mean growth .		1.5	1.0	0.5	0.25	0.25	..	..	..	..	Mean growth	
Age last birthday		17	18	19	20	21 to 22	23 to 50				Age last birthday	

Dawson (Liverpool Gaol). Dr. Beddoe (London).

A glance at these tables will also show how impossible it is to study the progressive development of man from mere averages. In 1000 men the average represents only a small fraction of the whole number of the same age, and differs from groups above and below it by containing only a few more individuals; and while the difference in height between an average lad of 17 and 18 years is half an inch for non-labouring, and an inch for the labouring classes, the difference between the tallest and shortest of lads at those ages is as much as 21 inches.

The *mean height* is the central or typical height which the men in the groups possess; and it is the variations of the individuals above and below the *mean* which are significant of the agencies at work in modifying the development of the body. Therefore it is I have given the whole range of heights which have been found to occur at each age of military life. The tables look formidable, but furnish materials of a wide scope for selection, when compared one with another.

The tables show that great changes go on in height according to age; that there is only an inch in difference between 17 years and 25 amongst *non*-labouring lads (the more favoured classes), and as much as 2 inches amongst the labouring population at those ages, with a mean annual growth of 2 inches at 17 years, and of half an inch between 25 and 30.

"Thus the contrast presented by the columns of

figures representing the 'non-labouring' and the artisan class shows the marked effect of social surroundings on the development of the body—the one class being retarded and depressed presumably by laborious occupations and various insanitary influences connected with their mode of life; the other class expanded and often exaggerated by the prevalence of circumstances favourable to growth." [1]

Let me now mention some other influences which modify growth, especially as to height.

Puberty is an important one, with a very marked influence—an influence I have already pointed out as regards the growth of the heart.

With the accession of puberty in the non-working classes there appears to be an increased rate of growth towards *height* (Roberts), and an entire cessation of it at 19 or 20 years; while in the industrial labouring classes growth towards height appears to be more uniform, and less influenced by puberty, extending to about the 23d year.

Hence in the selection of any particular individual it should be remembered that there are certain periods of life at which the growth towards height is more or less arrested, and there are also times of growth more or less rapid than others (Quetelet). These arrests of growth or anomalies as to development are most obvious about the age of puberty, and also after illnesses of a severe kind, and it is probably to the greater or less

[1] Roberts, p. 99.

development about the time of the accession of puberty that the *final differences* in the height of an individual are in a great measure to be attributed. Hence the influences which promote or retard growth at the period of puberty are most deserving of extensive investigation.

The transition from boyhood to manhood extends over a period of 3 or 4 years, and is accompanied by increased physical development of the whole body. In the female, on the other hand, the accession of puberty, *i.e.* the transition from girlhood to womanhood, is completed in a few months generally, and with complete establishment of the catamenia, growth is usually retarded and often ceases altogether. There appears also to be a wider range in the heights of adult women than in adult men, and this difference is due in a great measure to the suddenness of the accession of puberty in women as compared with men, and the check it certainly gives to growth. It has also been found that puberty has been attained later in tall women than in short ones.

Another influence at work in modifying growth is the effect of acute diseases. Their occurrence promotes a more rapid growth of the body, and, although a well-established fact, it is difficult to account for, unless it be that increased germinative changes take place in all the tissues of the body which are stimulated by the general febrile state — the continuous persistent increase of temperature — stimulating growth in the harder parts, and so

producing more rapid lengthening of bones and growth of cartilages.

Severe manual occupations tend also to retard growth in height, and to promote lateral development —working in mines, for example. To such unsuitable labour is to be added deficient diet.

It may be convenient to call attention here to certain special requirements which are sometimes called for in recruits for some arms of the service which have an undoubted predisposing influence in causing disease. It is this—namely, that some of the physical standards for recruiting the army are in a great measure arbitrary, and are apt to be based rather on æsthetical than on physiological considerations. Some of those standards, especially as regards height, have been such that they cannot include the greater number of the best developed and best proportioned individuals of the class from which recruits are drawn, because the prescribed requirements are incompatible with healthy physiological life. Practically the military authorities may choose to form an army composed of men of any age or of any height which they can obtain; and sometimes the requirements in this respect have been altogether fanciful. For example, in the *Report on Recruiting*[1] for 1876, it is stated that "there is, not unnaturally, a tendency on the part of commanding officers to take exception to small men, from the strong desire to command battalions composed of taller and more showy soldiers."

[1] *L. c.*, p. 2.

This fanciful desire has not been confined to soldiers of our own country. The historian Macaulay, in his *Review of the Life of Frederick the Great*, gives a humorous account of the ambition of that monarch's father which illustrates this point. "The taste of Frederick William the First for military pomp and order became a mania like that of a Dutch burgomaster for tulips . . . and no price was thought too extravagant for tall recruits. The ambition of the king was to form a brigade of giants, and every country was ransacked by his agents for men above the ordinary stature. These researches were not confined to Europe. No head that towered above the crowd in the bazaars of Aleppo, of Cairo, or of Surat, could escape the crimps of Frederick William. One Irishman, more than 7 feet high, who was picked up in London by the Prussian ambassador, received a bounty of near £1300 sterling—very much more than the ambassador's salary. This extravagance was the more absurd, because a stout youth of 5 feet 8 inches, who might have been procured for a few dollars, would in all probability (as Macaulay justly observes) have been a much more valuable soldier. But to Frederick William this *huge* Irishman was what a brass Otho or a Vinegar Bible is to a collector of a different kind."[1] The Irishman was James Kirkman.

So much for the independent evidence of a great historian, which confirms the existence of the desire

[1] Macaulay's *Works*, vol. vi., Essays, p. 647; also Carlyle's *Life of Frederick the Great*, vol. i. pp. 575-606; or People's Edition, vol. ii. p. 93.

to command battalions composed of soldiers taller than average human beings.

On the other hand, very *short* men are not less objectionable, especially in infantry, inasmuch as their strength, weight, and impulse are not sufficient. "It is usually said, indeed, that 'a little man's bullet has its billet as sure as a big man's.' Firing, however, is but part, and a small part too, of a soldier's work. Besides, taking men overhead, *the strong will fire faster, longer, and more true than those who are weaker;* and if allowance be made for exceptional instances of short men possessed of massive muscle, and tall men very spare in that respect, *stature on the whole rules strength, and work, if not skilled.*"[1]

As stature is of first importance amongst the "*physical equivalents*" of age, more especially the *mean* stature of the population, at the full growth of adult age—at 23 to 25 years—the data given on the following page are important.

From these data it may be taken that a range of from 1 to 2 inches may be expected of growth from 19 to 25 years of age. Above *mean* height at that age, and still more at 18 years of age, the experiences of Drs. Balfour and Lawson (both of them distinguished officers of the Army Medical Department, now retired), as shown in their Reports for 1860 to 1864, indicate that a recruit of 18 years of age may be expected to increase 1 inch in stature, $1\frac{1}{2}$ inch in chest-girth, and 10 lbs. in weight, *before*

[1] *Life of Sir Robert Christison, Bart.*, vol. i. p. 216.

TABLE XX.—The Mean Height of the Male Adult at Full Growth, compared with Mean Height at 19 Years of Age, in this and some other Countries.

Mean Heights at 19 Years of Age.	Mean Heights at Adult (25 Years).	Difference.
Belgians (Quetelet) . . 5′ 5″.16 = 1.655 metres.	5′ 6″.22 = 1.682 metres.	1″.06 = .027 metres.
American White (J. H. Baxter) 5′ 7″.07 = 1.7036 ,,	5′ 8″.22 = 1.7328 ,,	1″.15 = .0708 ,,
Criminal Classes (Danson) . 5′ 4″.94 ...	5′ 6″.30 ...	1″.36
Englishmen (Roberts)—		
Labouring Class . 5′ 6″.5 ...	5′ 6″.5 ...	.5
Non-labouring . . 5′ 8″.75 ...	5′ 9″ ...	.25
English (Beddoe and Amer) 5′ 6.″577 = 1.6911 metres.	5′ 6″.6 = 1.6934 metres.	0.32
Scotchmen (Beddoe)	5′ 7″.5 ...	...
Viennese (Liharzik) . . 5′ 4″.96 ...	5′ 8″.90 ...	3″.94
Genoese (Dunant) . . ... 1.674 metres.	1.688 metres.	.014 metres.

he reaches the age of 23 years. Several other noted observers have also come to the same conclusion.

Too much importance has ever been attached to mere stature alone in selecting recruits; and a high standard of height does not necessarily produce men best fitted for military duties. The taller the recruit the more important it becomes that he should be tested by the spirometer. The cases of phthisical disease are largely supplied by them, *e.g.*, in the Guards.

There is, in fact, "no actual relation between mere stature and aptitude for military service," as M. Boudin long ago demonstrated. Statistics also show that "the ratio of rejections increases with increase of height."[1] Practically, therefore, when large numbers of men are needed, no restriction *as to height* should be announced as obligatory. *Mean* stature varies under the influence of race; so that the application of one uniform standard of height is certain to result in the rejection of many efficient and capable recruits.[2] If a *minimum* is fixed, it ought to be made to vary, according as the mean stature of the different races is found to vary. But this is so great a difficulty, from the want of any statistics in this country on that point, that it is wiser not to fix a standard, but to trust to the physique, as shown in the correlation of age, height, weight, and chest-girth, in the selection. There is no sound policy to be served in selecting any but the most physically perfect men.

[1] *Medical Statistics of the Provost-Marshal-General's Bureau*, vol. i. p. 72.

[2] *L. c.*, p 165.

TABLE XXI.—ACTUAL, AVERAGE, AND MEAN WEIGHTS, AND ANNUAL RATE OF INCREASE IN WEIGHT OF 5060 LADS AND MEN, AT AGES BETWEEN AND INCLUSIVE OF 17 TO 30 YEARS, OF THE MOST FAVOURED, *I.E.* NON-LABOURING CLASSES OF ENGLISH POPULATION. From Mr. Charles Roberts, F.R.C.S., *Manual of Anthropometry*, pp. 74, 75.

Age last birthday		17	18	19	20	21	22	23	24	25 to 30	Age last birthday	
No. of observations		1602	1522	794	391	340	205	91	45	70	No. of observations	
Weight, including clothes=9 lbs.											Weight, including clothes=9 lbs.	
Stones (14 lbs. = 1 stone) from	Lbs. from										Average lbs.	Average kilos.
14 to 15	196 to 200	..	2	1	..	6	..	..	21	14	203.1	92.27
13 to 14	182 to 196	4	8	6	5	12	10	..	..	15	189.0	85.91
12½ to 13	175 to 182	13	29	34	64	45	44	75	22	119	178.5	82.04
12 to 12½	168 to 175	27	43	53	51	84	69	75	65	90	171.5	77.95
11½ to 12	161 to 168	48	81	94	138	147	157	118	57	134	164.5	74.77
11 to 11½	154 to 161	109	123	130	162	155	221	172	152	135	157.5	71 59
10½ to 11	147 to 154	149	169	197	216	180	133	205	196	164	150.5	68.41
10 to 10½	140 to 147	170	195	192	182	143	154	151	196	149	143.5	65.22
9½ to 10	133 to 140	180	149	150	108	129	118	54	152	90	136.5	62.05
9 to 9½	126 to 133	139	104	98	49	75	55	108	44	45	129.5	57.83
8½ to 9	119 to 126	85	62	30	20	18	25	32	..	15	122.5	55.68
8 to 8½	112 to 119	45	31	12	5	6	14	10	63	30	115.5	52.50
7½ to 8	105 to 112	18	3	3	..	..	..	..	..	..	108.5	49.31
7 to 7½	98 to 105	10	1	..	..	..	..	..	..	..	101.5	46.13
6½ to 7	91 to 98	2	..	..	..	..	..	..	..	..	94.5	42.95
6 to 6½	84 to 91	1	..	..	..	..	..	..	..	..	87.5	39.78
Total . . .		1000	1000	1000	1000	1000	1000	1000	1000	1000	Total	
Average weight .		141.03	146.0	148.20	152.07	152.30	154.78	151.70	149.20	155.20	Average weight	
Average growth .		12.69	4.97	2.20	3.87	0.27	2.44	..	..	0.42	Average growth	
Mean weight .		140	146	148	150	152	..	..	..	154	Mean weight	
Mean growth .		14	6	2	2	2	..	..	..	2	Mean growth	
Age last birthday .		17	18	19	20	21	22	23	24	25 to 30	Age last birthday	

TABLE XXII.—ACTUAL, AVERAGE, AND MEAN WEIGHTS, AND ANNUAL RATE OF INCREASE IN WEIGHT OF LADS AND MEN, AT AGES BETWEEN AND INCLUSIVE OF 17 to 50 YEARS, OF THE ARTISAN OR LABOURING, *I. E.* LEAST FAVOURED CLASS AMONGST ENGLISH POPULATION. From Mr. Charles Roberts, F.R.C.S., *Manual of Anthropometry*, pp. 82, 83.

Age last birthday		17	18	19	20	21 to 22	23 to 30	23 to 50	Age last birthday	
No. of observations		504	147	105	68	93	121	142	No. of observations	
Weight, including clothes									Weight, including clothes	
Stones (14 lbs. = 1 stone) from	Lbs. from								Average lbs.	Average kilos.
13 to 14	182 to 196	..	..	..	..	..	8	7	189.5	85.91
12½ to 13	175 to 182	..	6	9	..	..	8	14	178.5	82.04
12 to 12½	168 to 175	..	..	..	..	32	33	35	171.5	77.95
11½ to 12	161 to 168	..	13	..	..	32	42	49	164.5	74.77
11 to 11½	154 to 161	6	15	19	15	65	99	106	157.5	71.59
10½ to 11	147 to 154	10	27	57	73	32	58	71	150.5	68.41
10 to 10½	140 to 147	30	48	124	132	183	198	190	143.5	65.22
9½ to 10	133 to 140	47	75	153	177	161	182	162	136.5	62.05
9 to 9½	126 to 133	135	251	200	294	269	165	162	129.5	57.83
8½ to 9	119 to 126	159	170	124	132	86	116	106	122.5	55.68
8 to 8½	112 to 119	278	224	219	118	118	75	70	115.5	52.50
7½ to 8	105 to 112	137	75	76	44	22	8	14	108.5	49.31
7 to 7½	98 to 105	125	61	19	15	..	8	7	101.5	46.13
6½ to 7	91 to 98	41	14	..	..	..	..	7	94.5	42.95
6 to 6½	84 to 91	24	8	..	..	..	..	..	87.5	39.78
5½ to 6	77 to 84	6	7	..	..	..	..	..	80.5	37.50
5 to 5½	70 to 77	2	6	..	..	..	..	..	73.5	33.41
Total . . .		1000	1000	1000	1000	1000	1000	1000	Total	
Average weight .		116.4	123.3	128.4	130.6	135.4	139.0	141.2	Average weight	
Average increase .		7.66	6.97	5.08	2.20	4.81	3.58	5.74	Average increase	
Mean weight .		116	122	128	132	136	138	140	Mean weight	
Mean increase .		10	6	6	4	4	2	4	Mean increase	
Age last birthday.		17	18	19	20	21 to 22	23 to 30	23 to 50	Age last birthday	

Weight.

The next important series of "*physical equivalents*" in relation to age concerns the "*actual average and mean weights, and annual rate of increase in weight of males in England*, as given in the preceding Tables XXI. and XXII., pp. 186, 187.

The study of the weight of the body in relation to development and growth implies a knowledge of (1) absolute weight without clothes, or in the light dress of the gymnasium ;[1] (2) rate of increase from year to year ; (3) relation of weight to height and age.

The tables are taken from the extensive data given by Mr. Roberts, and contain all the reliable statistics which exist as to *weights* of males in this country at the ages which concern the recruit and young soldier.

The weights are arranged in groups differing from each other by *two pounds ;* and the observations are reduced to a uniform rate per 1000.

Weight alone is perhaps the least reliable of physical equivalents in relation to age, much more influenced by accidental causes than height or girth. Abundance of food and a good digestion favour a disposition to obesity, especially as life advances.

In an age of luxury, and in periods of indolence, prosperity, and plenty, we are apt to eat more than is absolutely necessary for our wants, especially

[1] If taken in clothes deduct 10 lbs.

when digestion is good and the viands are good, and we are in the companionship of those who are pleasant and sociable.

All these circumstances are important modifying agents as regards growth, which must be taken into account, for the results are markedly different when the non-labouring classes are compared with the labouring classes, so that the "physical equivalents" of weight in relation to age are very different in the one class compared with the other—a mean of 140 lbs. in the one, as against 116 in the other at 17; and 148 lbs. at 19 as compared with 128 at that age.

Looking to the relation of weight to age, it is found that after *nine* years of age a rapid increase of weight begins which culminates at 16 or 17 years in an increase of 16 lbs. for that year—the 16th. From the age of 17 the annual rate of increase diminishes till the age of 23 or 24, after which little or no increase takes place under ordinary healthy physiological circumstances till 30 years of age. So up till 30 years of age the adult man ought to be in the enjoyment of the greatest physical activity—swift of foot, lithe of limb, good at football, cricket, tennis, racquets, and all athletic sports, or work requiring a *maximum* of exertion. But after 30 years of age the tendency is towards obesity, which begins to increase, and so weight also increases after 30, as a pathological rather than a physiological process, mainly due to the excessive formation of fat, which accumulates about the walls

and contents of the abdomen. We then get broad and bulky over the loins and hips; the omentum increases also, so that we become bulky before as well as behind. Rapidity and agility of movements are thus greatly impaired and diminished. The heart and the lungs also find that they have an enlarged sphere of labour, so that they work under increasing physiological difficulties. Hence after 30 years of age we are unable to run so fast as we were wont to do; and ascending stairs, climbing hills, or rapid walking tries the wind.

The American statistics fix the increment of weight within the limits of 61 to 71 inches of stature at 5.96 lbs. Mr. Hutchinson's results give an increment of 5.14 lbs.; and Mr. Gould's, 4.25 lbs.—an average of 5.07 lbs. It has been inaccurately supposed that an increment at the rate of 2 lbs. for every inch of stature constitutes a sound body, and that an increment below that proportion ought to suggest some disqualification.

"A man of 60," or 61 inches, "would be fully up to the standard of health if his *weight* were 120 lbs., and it should not exceed 130 lbs.; but this rate becomes rapidly insufficient with advancing stature; and a man of 6 feet in height weighing only 144 lbs., might fairly be considered as emaciated."[1]

It is found that the relation of *weight* to stature increases rapidly in ratio when the height exceeds 5 feet 2 inches, so that at 5 feet the proportion

[1] Baxter, *American Medical Statistics*, *l. c.*, p. 54.

being about 1.85 to the inch, nearly 115 lbs. at 6 feet, it (the proportion) should be 2.50, about 180 lbs.[1]

TABLE XXIII.—VARIATION OF WEIGHT WITH AGE AT SAME STATURE.

Stature.	Weight at 18.	Weight at 19.
67 inches	126 lbs.	138 lbs.
66 ,,	120 ,,	130 ,,
65 ,,	116 ,,	121 ,,
64 ,,	115 ,,	120 ,,
63 ,,	117 ,,	117 ,,
62 ,,	111 ,,	113 ,,
61 ,,	102 ,,	119 ,,

Hence weight varies with age in lads and men who possess the same stature.[2]

Chest-Girth, Capacity, and Mobility.

The next series of "*physical equivalents*" in relation to ages are to be seen in the actual average and mean chest-girths, and their annual ratio of increase as represented in the Tables of Chest-Girth of Males in England.

As a military requirement chest-girth has only recently been introduced; *per se* it is no criterion of breathing power or endurance, but it is one more check

[1] Baxter, *American Medical Statistics*, *l. c.*, p. 56.
[2] Roberts, *l. c.*, p. 61.

on the correlative limits of inefficiency, and therefore chest-girth has now been ordered by the military authorities to be noted as a duty by the medical officer ; and a *minimum* of thoracic girth is now laid down for each corps of the British army. (See Appendices I. and II.)

The tables at pages 194, 195 represent the chest-girths of the general population of the country of the *non-labouring* and *labouring* classes.

Circumference of chest varies with the acts of respiration, hence there is a difficulty in measuring on a uniform plan, and different observers adopt different methods. The object aimed at in the examination of recruits is *to obtain the girth of the empty chest* in the first instance. The directions given are to pass a tape-measure quite horizontally round the chest at the level of the nipples, including lower portion of scapulæ, the arms to hang loose by the sides. At the same time the recruit is to count from 1 to 10 in a loud voice without taking a breath. This performance is supposed to gradually empty his lungs, and to exhaust the air in the chest ; but practically it very seldom does. The girth is then to be determined without too great pressure of the tape upon the skin.

The American instructions are, to pass the tape "around the chest over the inferior angles of the scapulæ, and directly *over the nipples*, the tape being pressed evenly *upon* the nipples in front, and the measurements are to be taken both at inspiration and expiration."

Chest-Mobility.—One of the best indications of the powers of endurance and fitness for great exertion is to be looked for in the *chest-mobility*, or extent of power of expansion of the chest-walls.

Two measurements of the chest ought, therefore, to be taken—first at the completion of inspiration, *i.e.* full inflation, or the *maximum* of expansion; and again at completed expiration, *i.e.* of the empty chest, or the *minimum* of expansion, and the result expressed thus, $\frac{37}{35}$ inches. This is the only efficient way, the regulation method being quite fallacious.

The rate of *mobility* of the chest in quiet ordinary breathing at completed expiration and inspiration gives what has been termed the "*pulmonary play;*" and the "*vital capacity*" of Hutchinson indicates the number of cubic inches of air expelled from the lungs under these conditions.

The "*mean girth of the chest*" in the following tables is that of completed expiration. It does not seem to be quite determined whether the development of the thorax increases in *regular* relation to increasing stature; and very tall men are apt to be not so well proportioned in this respect as men of less stature. Nevertheless, the American results show that as regards the white natives of the United States "the *girth* of the chest increases as the height extends with characteristic regularity." So also Dr. Balfour's measurements of recruits for the English army shows a regular increase of girth with increasing height.

TABLE XXIV.—Actual, Average, and Mean Empty Chest-Girth an Annual Rate of Increase of Lads and Men, between and in clusive of Age from 17 to 30 Years of Age, of English Favoure *i.e.* Non-Labouring Classes. From Charles Roberts, F.R.C.S *Manual of Anthropometry*, p. 76.

Age last birthday		17	18	19	20	21	22	23	24	25 to 30	Age last birthday
Empty chest-girth											Empty chest-girth
Inches from	Average inches										Average metres
42 to 43	42.5	..	..	..	..	1	..	..	..	1	1.079
41 to 42	41.5	..	1	2	1	..	..	..	1	2	1.054
40 to 41	40.5	2	1	4	5	4	1	2	1	1	1.028
39 to 40	39.5	9	17	6	7	4	9	5	..	4	1.003
38 to 39	38.5	29	44	24	13	17	11	5	2	3	0.978
37 to 38	37.5	64	93	36	39	33	22	11	6	6	0.952
36 to 37	36.5	142	128	79	58	66	32	12	7	14	0.927
35 to 36	35.5	192	224	144	71	64	28	19	7	14	0.902
34 to 35	34.5	282	296	202	100	68	51	10	9	11	0.876
33 to 34	33.5	298	282	150	64	44	28	9	8	4	0.851
32 to 33	32.5	275	194	98	32	32	16	8	3	4	0.826
31 to 32	31.5	143	106	52	13	11	7	3	2	2	0.800
30 to 31	30.5	54	39	10	3	3	2	3	..	1	0.775
29 to 30	29.5	16	8	4	2	..	..	..	..	..	0.749
28 to 29	28.5	5	..	..	..	..	..	..	..	..	0.724
27 to 28	27.5	2	..	..	..	..	..	..	..	..	0.698
Total . .		1513	1433	811	408	347	207	87	46	67	Total
Average chest-girth		33.98	34.44	34.77	35.25	35.42	35.30	36.10	35.96	..	Average
Average increase .		0.90	0.46	0.33	0.48	0.17	..	0.60	..	..	Average growth
Mean chest-girth .		34	34.5	34.75	35	35.25	35.5	35.75	36	36	Mean girth
Mean increase		1.0	0.5	0.25	0.25	0.25	0.25	0.25	0.25	..	Mean growth
Age last birthday .		17	18	19	20	21	22	23	24	25 to 30	Age last birthday

TABLE XXV.—Actual, Average, and Mean Empty Chest-Girth and Annual Rate of Increase of 919 Lads, from Ages of 17 to 50 Years, among the Artisan or Labouring, *i.e.* Least Favoured Class, of English Population. From Charles Roberts, F.R.C.S., *Manual of Anthropometry*, pp. 84, 85.

Age last birthday		17	18	19	20	21 to 22	23 to 30	23 to 50	Age last birthday
No. of observations		376	168	90	46	45	88	105	No. of observations
Empty chest-girth									Empty chest-girth
Inches from	Average inches								Average metres
37 to 38	37.5	..	..	..	..	..	..	10	0.952
36 to 37	36.5	..	..	..	..	..	23	19	0.927
35 to 36	35.5	..	..	11	..	22	45	48	0.902
34 to 35	34.5	..	6	..	21	67	91	114	0.876
33 to 34	33.5	2	30	12	22	111	170	171	0.851
32 to 33	32.5	40	77	178	152	178	273	257	0.826
31 to 32	31.5	83	131	211	261	222	193	172	0.800
30 to 31	30.5	213	267	198	348	245	148	133	0.775
29 to 30	29.5	309	261	222	109	133	23	38	0.749
28 to 29	28.5	167	156	145	44	23	34	38	0.724
27 to 28	27.5	131	42	12	22	..	..	..	0.698
26 to 27	26.5	32	24	11	21	..	..	..	0.673
25 to 26	25.5	21	6	..	..	..	..	..	0.648
24 to 25	24.5	2	..	..	..	..	..	..	0.623
Total . . .		1000	1000	1000	1000	1000	1000	1000	Total
Average chest-girth		29.38	30.07	30.56	30.86	31.61	32.38	32.62	Average chest-girth
Average increase .		0.41	0.69	0.49	0.30	0.75	0.77	0.24	Average increase
Mean chest-girth .		29.5	30.0	30.5	31.0	51.5	32.0	32.5	Mean chest-girth
Mean increase .		1.0	0.5	0.5	0.5	0.5	0.5	0.5	Mean increase
Age last birthday .		17	18	19	20	21 to 22	23 to 30	23 to 50	Age last birthday

It is not easy to determine at what age the growth of the chest may be considered as completed. Certain pursuits and occupations by exercising the muscles of the breast and back, and favouring the deposition of fat at the approach of middle age, tend to produce some uncertainty as to the actual size of the thorax.

But there is no doubt that if the mobility of the chest be very limited, such a condition should be regarded as a disqualification for military service. Hutchinson considered 3 inches to be the healthy *mean mobility* of the chest, and he records a case in which it reached $6\frac{1}{4}$ inches, with a cubic capacity of 300 cubic inches;[1] and Gould speaks of six white soldiers in whom it was over 7 inches. The American records[2] show many cases of chest-mobility reaching 7 inches; in one case it gave $6\frac{3}{4}$ inches, *i.e.* a chest circumference of 33 inches expiration, $39\frac{3}{4}$ inches full inspiration; height, 5 feet 10 inches; weight, 162 lbs. He was rejected for inguinal hernia; and the remark is made as more than a mere coincidence, that in a number of cases of rejection for hernia an unusual degree of mobility of chest was found to exist.

Another instance is given at 18 years of age, with a chest circumference represented by 29 inches at expiration and 36 inches at full inspiration; a mobility of *seven* inches; height, 64 inches; and weight, 116 lbs. He was accepted for service.

[1] Hutchinson, *l. c.*, p. 222.

[2] Baxter, *l. c.*, p. 44.

One inch was not considered so small an expansion as to warrant exemption in recruits for United States army, as 7 were accepted possessing only that mobility. One would like to know how it fared with them! But they were adults; their mean age being 35.14 years; height, 68.47 inches; weight, 146.52 lbs.; and chest-girth, 33.35 inches.

It does not seem that chest-mobility bears any relation to age, while girth of chest does exhibit a striking regularity in its progressive relation to age; and no conclusions of any value can be arrived at unless the corresponding qualities of height and weight be also present in each case.

It is very obvious from the tables given and the context that the "*physical equivalents*" in relation to age vary to a marked extent in accordance with several modifying influences, *e.g.*—

(1) The labouring as distinguished from the non-labouring population.

(2) Height is modified especially by puberty and by its more or less rapid advent. With its accession the rate of growth is increased in the non-labouring classes, while growth in the labouring classes is less influenced by it.[1]

(3) The occurrence of acute disease has a markedly modifying influence in promoting or retarding growth; therefore its existence, previous to enlistment, ought to be carefully inquired into on pathological as well as on physiological grounds; and

[1] Roberts, *l. c.*, p. 98.

(4) It will be seen that another very important modifying influence is "Race," which hitherto has been little regarded. Its influence is well marked, however, and a great deal of attention has been given to it of late years.

The physical condition, therefore, of the population of the British Isles whence our recruits are drawn is of importance to be examined from a racial point of view.

In 1875 a Committee was appointed by the British Association for the purpose of collecting observations on the physical condition of the population of the British Isles. Up to 1883 it has made five *interim* Reports.

The points of inquiry have been as to (1) stature; (2) weight; (3) chest-girth; (4) complexion—colour of eyes and hair; (5) breathing capacity; (6) strength of arm; (7) of sight; (8) span of arms; (9) circumferences of head, arms, and legs.

Of these the observations on breathing capacity had to be given up on account of the imperfection of apparatus for determining what has been called "the vital capacity of the lungs."

The conclusions arrived at and the construction of numerous tables have been based on a total of 53,000 individuals of both sexes and of all ages.

The general results may be summarised as follows:—

(1) *As to height*:—The Scotch stand first (68.61 inches) when full grown; the Irish second (67.90

inches); the English third (67.36 inches); and the Welsh last (66.66 inches); the average of the whole being 67.66 inches.

(2) *As to weight*:—The Scotch take the first place (165.3 lbs.); the Welsh second (158.3 lbs.); the English the third (155 lbs.); and the Irish the fourth (154.1 lbs.); the average weight of the whole being 158.2 lbs. Thus the Scotch are the tallest and heaviest, the English take the third place in both tables, while the position of the Welsh and Irish is reversed; the Irish, occupying the second place in stature, come last in weight, and the Welsh, though lowest in stature, stand second in weight. For each inch of stature a Scotchman weighs 2.406 lbs., a Welshman 2.375 lbs., an Englishman 2.301 lbs., and an Irishman 2.270 lbs. An adult Englishman of typical proportions has a stature of 5 feet $7\frac{1}{2}$ inches, a chest-girth of $36\frac{1}{2}$ inches, a weight of 10 stones 10 lbs., and is able to draw, as in drawing a bow, a weight of $77\frac{1}{2}$ lbs. These are *mean* proportions.

The *averages* give greater weight for height. They are:—Height, 5 feet $7\frac{1}{3}$ inches; weight, 11 stone 1 lb. = 155 lbs.; empty chest-girth, 36.46 inches; strength, 79.6 lbs. For every variation of an inch in stature above or below the averages, 2.301 lbs. weight, 0.542 inch chest-girth, and 1.182 lbs. strength must be added or subtracted to obtain the typical proportion.

This rule, however, is only approximately correct,

because variations in the stature depend largely on the length of the legs, whilst the other qualities depend chiefly on the size of the trunk.

Also, it is important to be noted that men of the age of 21 years measure $\frac{3}{4}$ of an inch more in the recumbent than in the standing position, for reasons explained at page 79; that the span of the arms across the chest is 2.31 inches in excess of the stature; and that the ratio between the sitting height and the standing height is as 1 to 1.906—the length of the trunk and head being 36.04 inches, of the lower limbs 32.66 inches, and the total height 68.7 inches.

The English proportions very nearly correspond with that of the average of the whole kingdom, so that, in these respects at least, the Englishman is the "typical Briton"—the Scotch being above and the Welsh below the general average, they thus, as it were, counterbalance each other.

Relative Stature and Weight.—The mean *stature* of males in England for full-grown adults is 67.36 inches. The mean *weight* of adult males is 155.0 lbs.

Hence tables which show the number of men per 1000 at each *height* are of use for determining the *minimum* stature of recruits for military service.

From the general run of the observations it appears that the *minimum* standard for Welsh recruits should be 2 inches lower, and for English and Irish recruits 1 inch lower, than for Scotch

recruits, if each of these nationalities is to contribute its relative quota of soldiers.

Race must therefore be regarded of importance as a modifying influence in relation to development and growth.

It is no less curious than important to note that the variations in stature, weight, and complexion existing in different districts, counties, or provinces of Great Britain and Ireland are mainly due to differences in *racial* origin and descent, and this influence of race is found to predominate over all others.

For example, we have good reason to believe that the ancient Caledonii, the Belgæ, and Cimbri, and the Saxons and Frisians, as well as the Danes and Normans, were all people of great stature ; while, on the other hand, the prehistoric races in Britain appear to have been of low or moderate stature.

Hence it comes about that the districts occupied by these various invading races show a *higher* stature than those where the descendants of the earlier stock only survive.

This is best seen when we arrange or separate a few of the counties where there has been the least admixture of foreign blood, and compare them together as follows :—

(1) *Early English* population as seen in Cardigan, Radnor, and Brecon—average, 66.59 inches and 169.3 lbs. weight.

(2) *Saxon* race as in Sussex, Berkshire, and

Oxfordshire—average, 67.22 inches and 155.8 lbs. weight.

(3) *Anglican* population as in Lothians, Northumberland, and Norfolk—average, 68.73 inches and 166.7 lbs. weight.

(4) Scandinavian race as in Shetland, Caithness, North and East Yorkshire and Lincolnshire—average, 68.32 inches and 162.7 lbs. weight.

(5) The very tallest men (average stature 5 feet $9\frac{1}{2}$ inches $= 69\frac{1}{2}$ inches and upwards) are found in the Scotch counties of Kirkcudbright, Ayr, and Wigtown on the one side, and the three Lothians and Berwickshire on the other. The next stage in height, 69 inches to $69\frac{1}{2}$ inches, is found to prevail also in Scotch counties, and the North and East Ridings of Yorkshire. The average of $67\frac{1}{2}$ inches to 68 inches is distributed over the English counties of Durham, Lancashire, Derby, Stafford, Suffolk, Essex, Kent, Berks, and Cornwall; 67 inches to $67\frac{1}{2}$ inches is found in Nottingham, Leicester, Rutland, Northampton, Bedford, Warwick, Worcester, Flint, Denbigh, Sussex, Hants, Dorset, and Devon. The London average is 66.92 inches. In the West Riding, Chester, Carnarvon, Anglesea, Merioneth, Montgomery, Cardigan, Brecon, Radnor, Cambridge, Huntingdon, Bucks, and Oxford, the average is found to be $66\frac{1}{2}$ inches to 67 inches; and the lowest average, 66 inches to $66\frac{1}{2}$ inches, belongs to Herts, Middlesex (ex-metropolitan), Surrey (ex-metropolitan), Shropshire, Hereford, Monmouth, Gloucester, Wilts,

Somerset, Glamorgan, Carmarthen, and Pembroke.[1]

(6) The relative stature of 90 different nationalities has been determined with considerable precision. For example—

With the exception of the few Polynesians of Samsa, Tahiti, and the Marquesas Islands, the English well-to-do class (professional and non-labouring population) head the list. The New Zealanders, Patagonians, Angamis, and Negroes of the Congo, are nearly of the same stature as those last named.

The Scotch head the list of civilised races, but slightly exceed the general population of the British Isles, and the white population of the United States of America, which are almost identical in stature—the average of the British being 67.66 inches, and the Americans 67.46 inches, or 1.7182 metres (Gould).[2]

At the bottom of the list stand the Lapps, the Andamanese, and the Bushmen of South Africa.

The average between the taller and shorter races is $16\frac{1}{2}$ inches, and the average stature of the whole

[1] At page lxviii of introduction to *Murray's Guide to Devon and Cornwall* is the following interesting evidence:—In these counties "the men are a broad-shouldered race, above the average in stature; and it is a fact that West-country regiments, when drawn up with those of other counties, have covered a greater space of ground, the numbers being equal."

[2] This average does not quite tally with the American mean given in Table XX., p. 184; and unfortunately it is not possible to compare the results of the *Provost-Marshal-General's Bureau* with Mr. Gould's, on account of Mr. Gould having in some instances grouped together separate States.—*L. c.*, p. 28.

human race, according to actual observation, is 5 feet $5\frac{1}{4}$ inches (65.25); or about that of the Austrians and the French working classes.

These results, and the American statistics of the United States, confirm, and in no sense contravene, Boudin's well-known law, that "height is always an affair of race."[1]

This great principle of nationality and influence of race in the selection of men for military service has been of late very much insisted upon by our greatest generals who have seen warfare carried on.

The experience of General Sir Archibald Alison, who has seen service in the Crimea, in India, on the Gold Coast, and in Egypt, is, that the great principle of nationality in the ranks has always worked for good and not for evil. He says that "it has caused emulation amongst soldiers; that it has often in the past carried us through very critical periods in battle, and so no doubt it always will in the future."

Viscount Wolseley, a short time ago, said in Dublin that we had a Highland Brigade, and he hoped that in the future we should have an Irish one. But Sir Archibald Alison goes further. He trusts that "in the future we shall have English, Scotch, and Irish Brigades, each *commanded by men of their own nationality;* for as each nation has its own distinctive characteristics, so the men composing such brigades will be best understood and best handled by those of

[1] *Provost-Marshal-General's Bureau*, U.S. Government, Dr. A. M. Baxter, p. 20.

their own blood." Our soldiers are all united to uphold the distinction of the army; but there is besides, and there has always been in the army, a keen, generous rivalry as to which nationality shall best sustain this distinction on the field of battle. Thus there are two sentiments to which you can always appeal in the British and Irish soldier, and never appeal in vain. One is "The memory of his country," and the other is "The reputation of his corps." "Once try them," said Sir Archibald Alison, "and you have no idea of the power they possess." [1] "It was prominently shown when Sir Colin Campbell put himself at the head of the 93d Regiment at Lucknow in the crisis of the fight. And, again, when the 42d, with their swelling pipes, threw themselves into the heart of the savage Ashantee army in the woods of Amoaful; and yet, again, when the Highland Brigade advanced in one long wave upon the Egyptian intrenchments at Tel-el-Kebir." [2]

Hence I think we are justified in the conclusion that the influence of race is deserving of much consideration, especially in the selection of men who are to work together in the critical emergencies of warfare.

[1] Speech at Glasgow, October 12, 1883.
[2] *Times*, Friday, October 19, 1883.

SECTION X

SUMMARY OF RESULTS

HAVING in the previous section given an exposition of the methods by which the *mean* standards of *height*, *weight*, and *chest-girth* have been obtained, from which the probable age of an individual may be arrived at, and which therefore constitute what have been called "*the physical equivalents of age*," it is now required that we put the averages of all these physical equivalents side by side at the various ages from 17 to 30, as aids to determine the age of individuals, taking into account (as far as practicable) the various modifying influences already mentioned. We then decide the apparent age by comparing the *height* with the *weight*, *chest-girth*, and *general physical development and growth of the recruit*, recognising his antecedents in relation to modifying influences, especially in the search after evidence of "staying-power," of healthfulness of constitution generally, and freedom from disease.

The typical recruit at the ages varying from 18 to 25 is represented by those "physical equivalents" which are brought together in the following tables,

XXVI. and XXVII., as the summary or conclusions arrived at from the details given in the previous tables at pp. 176 and 177, 186 and 187, 194 and 195. The selection of lads and men ought to be made in accordance with the correlation of the averages of heights, weights, and chest-girths as deduced from the measurements of a large number of individuals of the various ages specified. In other words, the typical recruit at a fixed age, who has the average height and girth of body at that age, should also have the weight of body in accordance with such age, girth, and height, and these average equivalents, on the other hand, ought to be in accordance with age.

Hence we have only to place the groups representing the averages opposite to each other in order to see their correlation; and so observe that the law which fixes the type or average applies also (within certain limits) to the variation above or below the average—giving an ample range of *maxima* and *minima* to select from.

Our first inquiry in selecting a "growing lad" for military service concerns what may be termed "the life-power of the recruit." That is to say, the possession of such qualities as have been characterised by the terms "powers of endurance," "staying-powers," "stamina," or "grit." This inquiry at once suggests the question: How can we best ascertain the capacity or fitness of the individual for fulfilling a prescribed duty; and especially as to his possession of, or deficiency of, these special qualities of

TABLE XXVI.—Summary of Tables XVIII., XXI., and XXIV., showing Average Heights, Weights, and Chest-Girths, and Annual Rate of Increase from 17 to 30 Years of Age, the *Maxima* and *Minima* of these, and the Range of *Maxima* and *Minima*, from Public Schools, Naval and Military Cadets, Medical and University Students, *i.e.* Well-Favoured, Non-Labouring Classes.

	Height in inches without shoes.					Weight including clothes (7 to 10 lbs.)					Empty chest-girth in inches.				
Age last birthday.	Maximum.	Average.	Minimum.	Range.	Average annual growth in inches.	Maximum.	Average.	Minimum.	Range.	Average annual growth in inches.	Maximum.	Average.	Minimum.	Range.	Average annual growth in inches.
17	76.5	67.84	56.5	20.0	1.46	189.0	141.03	87.5	101.5	12.69	40.5	33.98	27.5	13.0	0.90
18	77.5	68.29	59.5	18.0	0.43	203.0	146.0	101.5	102.5	4.97	41.5	34.44	29.5	12.0	0.46
19	77.5	68.72	60.5	17.0	0.43	203.0	148.20	108.5	95.5	2.20	41.5	34.77	29.5	12.0	0.33
20	76.5	69.13	63.5	13.0	0.41	189.0	152.07	115.5	73.0	3.87	41.5	35.25	29.5	12.0	0.48
21	74.5	69.16	62.5	12.0	0.03	203.0	152.34	115.5	87.5	0.27	42.5	35.42	30.5	12.0	0.17
22	75.5	68.93	62.5	13.0	...	189.0	154.78	115.5	73.5	2.44	40.5	35.30	30.5	10.0	...
23	74.5	68.53	64.5	10.0	...	178.5	151.7	115.5	63.0	...	40.5	35.50	30.5	10.0	0.08
24	73.5	68.95	64.5	9.0	...	203.0	149.20	115.5	87.5	...	41.5	36.10	31.5	10.0	0.60
25 to 30	74.5	69.06	63.5	11.0	...	203.0	155.20	115.5	87.5	0.42	42.5	35.96	30.5	12.0	...

TABLE XXVII.—Summary of Tables XIX., XXII., and XXV., showing the Average Heights, Weights, and Chest-Girths, and Annual Rate of Increase from 17 to 30 Years of Age, the *Maxima* and *Minima* of these, and the Range of *Maxima* and *Minima*, among the Artisan or Labouring Class of the English Population.

	Height in inches without shoes.					Weight including clothes (7 to 10 lbs.)					Empty chest-girth in inches.				
Age last birthday.	Maximum.	Average.	Minimum.	Range.	Average annual growth in inches.	Maximum.	Average.	Minimum.	Range.	Average annual growth in inches.	Maximum.	Average.	Minimum.	Range.	Average annual growth in inches.
17	71.5	64.45	56.5	15.0	1.52	157.5	116.4	73.5	84.0	7.66	33.5	29.38	24.5	9.0	9.0
18	71.5	65.47	55.5	16.0	1.02	178.5	123.3	73.5	105.0	6.97	34.5	30.07	25.5	8.0	0.5
19	71.5	66.02	61.5	10.0	0.55	178.5	128.4	101.5	77.0	5.08	35.5	30.56	26.5	9.0	0.5
20	71.5	66.31	62.5	9.0	0.29	157.5	130.6	101.5	56.0	2.20	34.5	30.86	26.5	8.0	0.5
21 to 22	71.5	66.60	62.5	9.0	0.29	171.5	135.4	108.5	63.0	4.81	35.5	31.61	29.5	6.0	0.5
23 to 30	72.5	66.68	61.5	11.0	0.08	189.5	139.0	101.5	88.0	3.58	36.5	32.38	29.5	7.0	0.5
23 to 50	72.5	66.65	60.5	12.0	...	189.5	141.2	94.5	95.0	5.74	37.5	32.62	29.5	8.0	0.5
Dawson	...	66.39	...	...	...	...	143.7	...	...	...	...	...	...	...	...
Beddoe	...	66.72	...	...	...	...	137.7	...	...	...	...	...	...	...	...

constitution and physique which are necessary and requisite for military service in its widest sense, *i.e.* service on sea as well as on land?

In general terms, the characteristics we seek for in a good recruit are:—superior physical organisation, superior muscular force and capacity to resist nervous wear and tear—an organisation not apt to be upset by outside influences. And such qualifications are more likely to be found in the man or lad of coarse fibre than in the man or lad of delicate organisation. The former is the more eligible material in which to look for those powers of endurance which are required in the rough life of the soldier. One of the military maxims of Napoleon I. was that "The first quality of a soldier is the ability to support fatigue and privation; physical courage is only the second." Unfortunately his philosophy did not always prevent him from impressing into his ranks when it suited his purpose very young lads, who, when confronted with unlooked-for resistance, proved wholly wanting. And Christison's observation is well worth attention in relation to the arms of precision of the present day in the hands of weak and immature as compared with matured and efficient soldiers (see p. 183).

A much more ancient authority—Vegetius—writes that "it is of much more importance that a soldier should be *strong* than that he should be tall."

HEIGHT.—Practically, it would be of great im-

portance if we could determine what is the height at 18, 19, or 20 years of age which is attended with the greatest amount of health, strength, and endurance, *i.e.* the best physique; or is it possible to fix such a standard?

The Tables XXVI. and XXVII. show that at 18 years of age the *average* height amongst the better favoured, non-labouring classes is as much as 67 to 68 inches, and amongst the labouring or artisan classes it is from 64 to 65 inches.

In the British service the *minimum* height has, as a rule, been above the average height of the population at the age of 18 years, and this has no doubt needlessly limited the choice of men; and for some arms of the service it is so still.

Practically, the greatest military nations of the modern world have gone 2 inches or even more under the average height of the population at the recruiting age of 18, and found no disadvantage or deterioration in the quality of their soldiers. It does not, therefore, seem desirable that the British service should fix so high a standard as to height for some of the arms of the service as now exists.

The lowest stature of the Roman soldier was 63 inches of our measure (Vegetius).

The lowest stature in the American army was 64 inches for infantry and 65 inches for cavalry at 18 years of age (Baxter).

In the American War it is on record that men of less stature than 60 inches broke down by a few

weeks' campaigning, while men of 60 inches stood the work well (Hammond).

As to height, "In former days, when it was necessary to make use of a ramrod in loading a musket, men of a sufficient height to do this were absolutely necessary for the service; but in these days of breechloading arms, a man from 60 to 64 inches in stature, and well-proportioned as to build and weight, is *ceteris paribus* as serviceable a soldier as can be desired." [1]

"The objection as to shortness applies mainly to the infantry. If it is agreed that a man between 5 feet 3 inches and 5 feet 4 inches, when properly developed, and with a good chest, can make a good infantry soldier, then the criticism as to shortness *quâ* shortness falls to the ground. It is only intended that exceptionally good men under 5 feet 4 inches should be taken, and such men can only be enlisted specially, and with the joint assent of the approving and medical officers. Objections to any individual men enlisted under these conditions, or under any conditions whatever, must be duly inquired into." [2]

With reference to the varied requirements for the different arms of the service, there is this to be taken special notice of—namely, that at an age so young as 18, a height much below the *average* of 64 inches (especially amongst the labouring or artisan class) is apt to have been the result of defective feeding in

[1] Dr. J. H. Baxter, *American Statistics, l. c.*, p. 52.

[2] *Report of Inspector of Recruiting* for 1884, p. 5, dated February 21, 1885.

early life, thereby tending to a diminution of the normal rate of increase and growth of the body. It is under such circumstances that stunted development and even disease are almost inevitable results. The constitutional tendencies of the future being are certainly fixed at an early age; and although the "growing lad" at the age of 18 may not appear to have any definite ailment, a height *even at,* and still more, *below* the *minimum* correlations of *height* and *weight, i.e.* anything at or below $55\frac{1}{2}$ inches and 74 lbs. weight, at that age would at once suggest a feeble frame, with a tendency to some constitutional disease, and obviously a youth unfit for enlistment.

With the *average* correlation of physical equivalents at the age of 18—namely, $65\frac{1}{2}$ inches, with a weight of 123 lbs., and a chest-girth of even $30\frac{1}{2}$ inches, a recruit may be considered eligible if otherwise healthy. It is found that such lads increase very much in chest-girth after a few months, if sufficiently fed and judiciously trained. There are numerous examples of this.

On the other hand, as the height approaches a *maximum* at the age of 18 (say $71\frac{1}{2}$ inches), with this stature, excessive when compared with the expansion, growth, and vital capacity of the lungs, unfavourable conditions or factors of unsoundness become very obvious, by the contrast of the tall body with the narrow and flat chest, in which the apices of the lungs approach too close to each other. It is in such cases that the reparative organs are out of

proportion to the body they have to nourish and sustain. A height, say of 68 or 69 inches at the age of 18 ought to have a correlative weight of 146 lbs., and a chest-girth of 34 inches.

From the requirements of the service there are, generally speaking, two types of recruits for selection.

In the first type lads are selected *because* they are of *low* stature at the *minimum* age—say 64 to 65½ inches. These are intended for drivers and artificers and tailors of the Royal Artillery, drivers of the Royal Engineers, and Infantry of the Line, with chest-girths varying from 33 to 35 inches. Lads for tailors may be taken at 62 inches, and with a chest-girth of 31 inches.[1]

In drivers of Artillery and Engineers and in Infantry of the Line the greatest activity is looked for; and this seems to be associated with short, "dapper," little men[2]—"cobby little fellows"—who have a set, square appearance beyond their apparent age. But even in times of the greatest pressure, such men at 18 years of age ought not to stand under a height of 61½ inches, a weight of 118 to 124 lbs., and a chest-girth of 30 to 34 inches, when empty.

The second type of recruit embraces lads of taller stature at 18 and 19 years of age—such as 66, 68, 70, or even 72 inches, whose weights and chest-girths ought to be in correlation with such heights. But any extreme height at the age of 18 is objection-

[1] Appendix I.

[2] "A *dapper* little man."—Milton. "Small and active; brisk; nimble; lively; neat."

able,—any height over 67 inches at that age must be looked upon with suspicion. As a rule, I think it will be found that *adult* men of middle size—67 to 69 inches—bear hard work better than taller men.

In the selection of such tall men at early ages the great difficulty to be guarded against is "want of stamina." In other words, it is necessary to be assured that the promising lads of 18 to 19 years of age are really promising—that they possess sufficient physical characteristics, such physique as will give reasonable assurance that in two or three years more they will turn out to be able-bodied men when fully grown at 23 to 25 years of age, of average weight and chest-girth in proportion to their height. All the most accurate observations (those of Maclaren, Roberts, Beddoe, and those taken at Chelsea) show that nothing is more variable than the *rate* of growth; and that it may be accepted as a fact that very little is added to stature after 23 years of age, while the greatest strides as regards height are made between 14 and 20 years of age. A recruit, therefore, of $64\frac{1}{2}$ to 65 inches at 18 years of age cannot be expected to add much more than an inch or an inch and a half to his height by the time he attains mature age, and at 19 years not more than half an inch.

As to WEIGHT, the year 1884 was the first year in which any *minimum* weight was laid down in the requirements of recruits. The chest-measurement and weight according to height were then left

to the discretion of the medical officer, who was governed by the appearance of the man, by his physical condition, and his power and prospect of development. After careful examination the medical officer pronounced the man fit or unfit for the service.[1]

Up to a comparatively recent period, therefore, *weight* has not been a regulated quantity or quality in requirements for the enlistment of recruits; hence the limited amount of information comparable on this point. It is only recently that *weight* has been mentioned in the English requirements. It is at present fixed at a *minimum* of 115 lbs. (see Appendix I.); beyond that *weight*, above or below the *average*, is left to the discretion of military medical officer. But for physiological reasons, a due proportion in the weight of the recruit or young soldier in relation to age and height is of as much importance as a well-formed and sufficiently mobile chest, and is of greater importance than mere height. Hence weight must always be duly considered in the estimate of physical fitness of the recruit and young soldier.

Weights range themselves in groups from the dwarfs to the giants, just as heights do at the varying ages.

Weight when excessive is attended with a loss of vital capacity, and Dr. Hutchinson came to the conclusion that 7 per cent above his standard rates

[1] *Report of Inspector of Recruiting* for 1884, dated February 21, 1885, p. 5.

of proportion of weight in relation to stature was the limit of allowable excess.[1]

As to weight, it is the exception rather than the rule to find a recruit up to the highest standard of weight; and this is more especially the case amongst town-bred than country-bred applicants for enlistment. The obvious reasons for this are to be found in the poverty of their circumstances—many enlisting from sheer want. Allowance must therefore be made for such previous circumstances, care, however, being taken not to allow too wide a margin. The size of the recruit's bones, his chest-girth, capacity, and expansion, as to extension and contraction of the thorax—the pulmonary play—in the acts of respiration are then the best indications of his physique.

It is found that city-bred youths are always the most doubtful. In spite of the advantages of good food, regular habits, and the salutary exercise of the gymnasium after enlistment, they do not easily come up to the standard of a good military physique.

Low weights at the ages of 18 and 19 are to be looked upon with suspicion. They ought always to carry with them some other compensating qualifications, especially satisfactory evidence of bodily development, thereby giving some guarantee of future promising increase.

Thus a lad of 124 to 130 lbs. at 18 years of age has to add at least *seven* more pounds to his weight

[1] Hutchinson, *Quarterly Journal of Statistical Society*, vol. vii. p. 166.

before he can be considered as having attained to anything like the development and growth of an able-bodied soldier at 23 to 25 years of age, having a weight of 131 to 139 lbs. at least.

The *minimum* weight of 115 lbs. at the age of 18 years (at present the requirement[1]) is too low. It more nearly approximates to the physical equivalent of 17 years of age; for 18 years of age the *minimum* weight ought not to be below the average of 120 lbs.

With regard to CHEST-MEASUREMENTS, the average dimensions of the chest furnish no conclusion of any value in the absence of the corresponding qualities of height and weight in relation to age in each case, and the influence of race is of importance.

The girth in relation to height, however, is important thus far, that if with a certain stature a corresponding or proportionate average girth of chest is not found to exist, the man is probably unsuitable for military service; and then other more important signs of unfitness may be found, and ought to be carefully looked for. If in addition the *mobility* of the thoracic movements is very limited, such a condition should be regarded as a disqualification.

Testing results by actual observation, the conclusion has been arrived at, that during the development of the body, the ratio between the *height*, *chest-girth*, and *weight*, is approximately as the

[1] Appendix I.

annual rate of increase, but within variable limits as to age.

Thus if a boy aged 10 years grows 2 inches in height, $\frac{1}{2}$ inch in chest-girth, and 4 lbs. in weight, by the time he is 11 years; another boy, aged 10 (but who is 2 inches taller), should have $\frac{1}{2}$ inch more chest-girth than the first, and be 4 lbs. heavier in weight.

This ratio will hold good to the utmost limits of boys of the age of 10 years, and for every excess or deficiency 2 inches in height from the mean there will be an excess or deficiency of $\frac{1}{2}$ inch of chest-girth, and 4 lbs. in weight. Generally, it has been found that "for each inch in height, the weight is increased 4 lbs. from 10 to 15 years; 6 lbs. from 15 to 16 years; 8 lbs. from 16 to 19 years; and from 19 to 30 years of age there are 6 lbs. to be added to the weight, while the height remains stationary."[1]

Generally, it is ordered that "if, in the course of his examination, any recruit, not coming quite up to the standard on any one point, has the appearance to the medical officer of being a promising lad, he can then be recommended to the recruiting officer, and a certain latitude as to height and chest-measurement is given to the approving officer, should he and the medical officer be of the same opinion as regards the man's eligibility. No man passed under these circumstances, therefore, can be admitted into the service except with the full concurrence of the medical officer and the district approving officer.[2]

[1] Roberts's *Manual*, p. 64. [2] *Report on Recruiting*, 1884.

SECTION XI

RECOGNITION OF MEN OF MATURE AGE

THE present conditions of enlistment of recruits require the medical officer to make his selection from three periods as regards age. He is required to recognise eligible young lads (1) at 18 and 19 years of age; (2) at the ages of 19 to 25; and (3) men of mature age from 25 and upwards. Men of too mature age endeavour to look younger than they really are. It is necessary to eliminate these aged would-be recruits as generally objectionable and unfit. It is also an object to prevent the enlistment after discharge of incorrigible drunkards, and men whose reformation after crime appears improbable. As such objectionable characters no longer bear "*marks of having been in military service*," it is necessary to take some trouble to exclude them from re-enlistment. The drunkards and the incorrigible are not generally found among the young soldiers, although some offenders are doubtless discharged as incorrigible under 25 years of age; but the majority of such incorrigible men have usually had several years' service. Hence, if the limits of age be fixed,

and if the real age be fixed with tolerable exactness by the medical officer, some security would be obtained that offenders discharged the service could not re-enlist.

By practice and by special study of the subject, as expounded in the previous pages, a military medical officer need have no great difficulty in determining, with reasonable exactness, the age of lads from 17 to 23. But the ages of men from 23 to 30 years are more difficult to determine. Nevertheless, if the military medical officer has sufficient time to make and record the observations on which his opinion rests, he may come to a satisfactory conclusion as to the ages of the older men. It is only by a careful comparison of many physical indications that any reasonable conclusion (as distinguished from a guess) can be arrived at respecting age, as there is *no single indication* that can be depended on to denote the real age.[1]

A detail of the physical indications or equivalents best calculated to guide the medical officer in forming an opinion on the age of recruits of mature age

[1] The probable error tends to increase with the age of the recruit after 18 years; and my friend, Deputy-Surgeon-General Dr. Henry L. Veale, has furnished me with the following scale of probable error—namely, at 18 years it may be 2+4=6, *i.e.* the recruit might be 16 or 22; at 20 years it might be also 2+4=6, *i.e.* he might be 18 or 24; at 22 years the error might be 3+5=8, *i.e.* he might be 19 or 27; at 24 years the error might be 4+5=9, *i.e.* he might be 20 or 29; at 26 years the error might be 5+6=11, *i.e.* the recruit's age might be 21 or 32; at 28 years the error might be 6+7=13, *i.e.* the age might be 22 or 35; at 30 years the error might be as much as 6+8=14, *i.e.* the recruit's age might be 24 or 38, and so on.

embraces, IN ADDITION TO those I have referred to in the preceding pages, an examination of the following points for comparison :—

(1) The *form* of the features in connection with

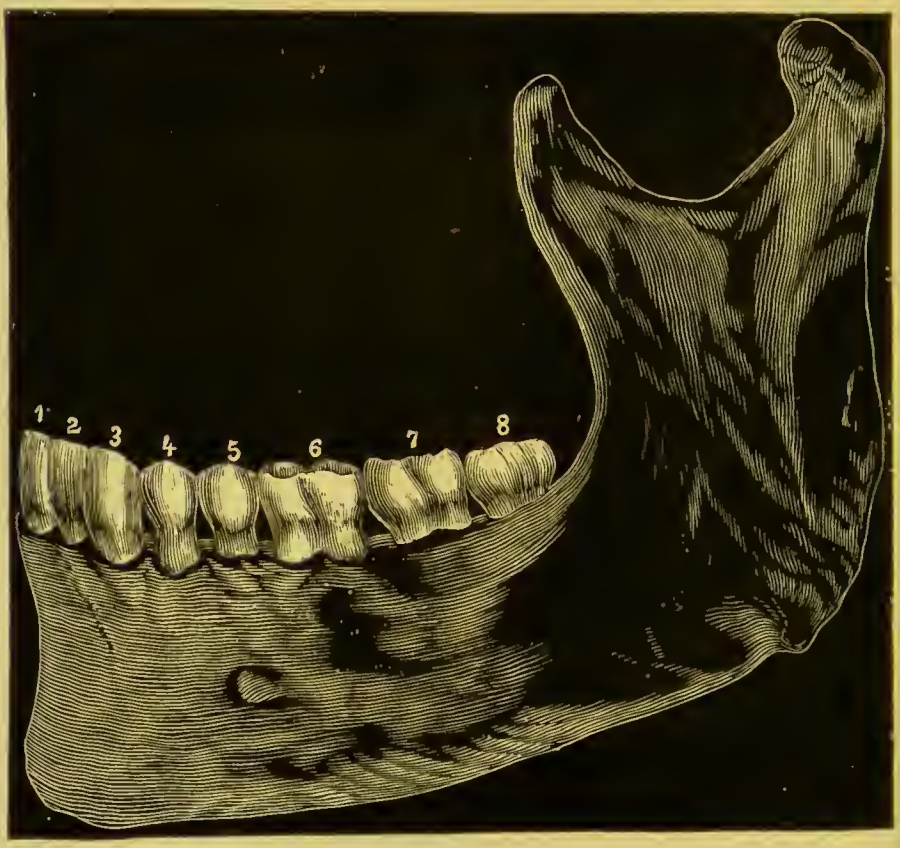

FIG. 21.—Side view of lower jaw in the mature man, with an angle of about 120°, and with the full set of *permanent* teeth, in which are : 1, the central incisors ; 2, the lateral incisors ; 3, the canines ; 4, the first bicuspids ; 5, the second bicuspids ; 6, the 6th year molars ; 7, the 12th year molars ; and 8, the wisdom teeth.

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the growth of the permanent teeth and development of the upper and lower jaw-bones. This is a very

important indication not touched upon in the instructions given for the examination of recruits.

A characteristic elongation of the face and upper jaw commences about 17 or 18 years of age, and goes on to 25, connected especially with the development of the hindermost molar teeth; and when it is

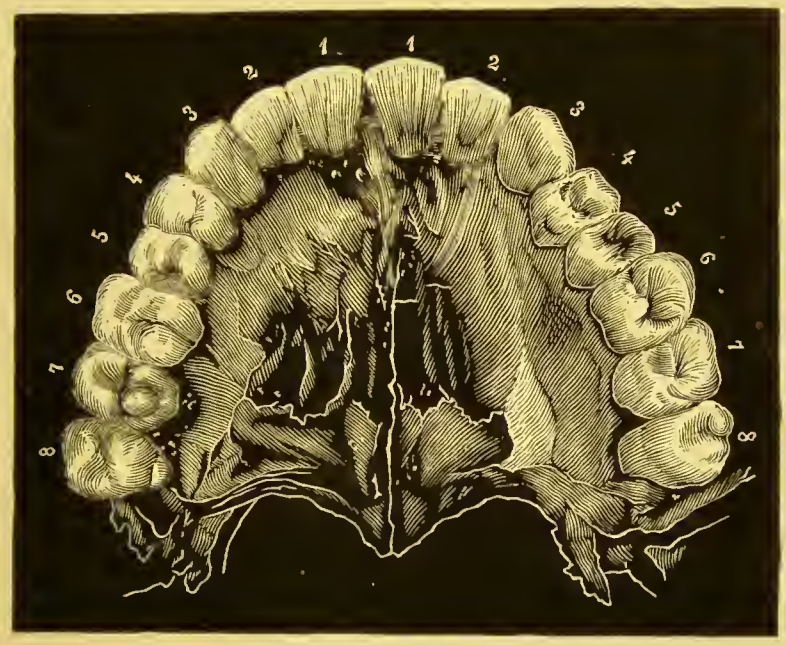

FIG. 22.—View of upper jaw in the mature man, showing a complete set of the upper *permanent* teeth.
By permission of Messrs. CHARLES GRIFFIN & Co.

complete the anterior margin of the ramus of the lower jaw is placed at nearly a right angle to the alveolar border. The angle of the jaw (which is the meeting of the posterior border of the ramus with the base) is then about 120°, and in men of

powerful physical development is sometimes not more than 110° or 112°.

Previous to the age of 17 years there is not sufficient room in the alveolar arch for the growing sacs of the permanent molars.

At and after 17 years of age the alveolar border becomes deep and broad, and continues to get deeper and broader at the hinder part as the wisdom teeth grow. This growth and enlargement of the jaw is for the accommodation of the permanent molar teeth.

At 17 years of age the wisdom teeth (8, Fig. 22) of the *upper jaw* lie in the maxillary tuberosity behind and above the second molars; in the *lower jaw* the wisdom teeth (8, Fig. 21) are embedded in the base of the coronoid process. The wisdom teeth afterwards descend, and successively assume their ultimate proper position as the jaw elongates. When the elongation of the jaw is complete, its arch-curve becomes semi-elliptical.

The development and appearance of the teeth are very rarely in advance of age, and the wisdom teeth, as with the other teeth, are developed and completed first in the lower and afterwards in the upper jaw. On the other hand, the eruption of the wisdom teeth in some men never takes place, and when there is such arrest of development, the other points suggestive of age must be all the more carefully inquired into. Arrest of development is most important to be noticed, in order that its cause may be carefully inquired into.

The elongation of the face and jaws is complete when the wisdom teeth are fully exposed and in position, about 25 years of age.

The progressive growth and change in position of the wisdom teeth and of the form of the jaw thus furnish a valuable guide in estimating ages between 17 and 25 years.

(2) The evidences of attrition from use in mastication, *in each separate class of teeth*, should be the subject of special examination. This examination must take into account the nature of the food on which the man seeking to enlist has been fed. In the north of Scotland, where young men feed largely on hard oatmeal cakes, or in the case of seafaring men fed on hard biscuits, the grinding teeth will be greatly more worn to a level on the surface of their crowns than the teeth of men fed on softer food.

(3) The external signs of puberty and comparative age of the beard furnish also some grounds for an opinion ; also the texture of the skin and its smoothness or freedom from wrinkles in certain parts, such as external angles of the eyes and edges of the muscles of expression of the face. The downy chin of 17 to 20 contrasts with the beard of older men, and repeated shaving of the beard discloses the cut surfaces of aged and mature hair.

(4) The gait of youth, and the tractile force of muscle from 17 to 20 years of age, are markedly different from those of the man of mature growth, in consequence of the relative dimensions of limbs to

trunk of body, and of the pelvis having undergone changes.

From 20 to 25 years of age the bones become thicker, the joints stronger, the shoulders broader, the muscles firmer and better developed. The gait of the man thus becomes firmer than that of the youth; and the tractile force of the muscles of men from 20 to 25 years of age gives from 366 to 413 lbs., and is greater than the force of youths from 17 to 20 years, in whom the tractile force is generally under 366 lbs., presuming that the individual has not been trained in this trial of strength, or has not worked at a trade which would be equivalent to such training.

(5) The concurrence of height, relative dimensions of individual parts, and development of the body generally with ages from 18 to 25, should be the subject of special examination.

The very extensive measurements of the human body recorded by the late Dr. F. P. Liharzik, of Vienna, and published by the Imperial Royal Court and State Printing Office of the Austrian Government, furnish the best basis for comparing the "law of increase" in the relative growth of different parts of the body as an indication of age.

Dr. Liharzik's results from 18 to 25 years of age represent a gradual and normal increase in relation with "*six fundamental dimensions*," so that the nearer the different parts of the body correspond with these dimensions the more regular is the growth of the body in accordance with age. Moreover, marked

deviations from these normal dimensions, especially as showing retarded growth of the chest at particular ages, are of practical value as indicating a tendency to scrofulosis.

The following are the six fundamental dimensions, upon which an estimation of the stature of man in relation to age is based, being portions of its total length at various ages :—

(1) The length of the head from its vertex to the apex of the chin, the man lying in the horizontal position and naked.

(2) The length of the neck from the apex of the chin to the upper margin of the sternum.

(3) The length of the sternum from its upper margin to the end of the xiphoid cartilage.

(4) The distance of the xiphoid cartilage to the upper margin of the pubic symphysis, the navel dividing this distance into two equal parts.

(5) The total length of the thigh and leg.

(6) The vertical elevation of the centre of the internal malleolus over the sole of the foot.

With these six fundamental dimensions the girth of the body at various parts and the horizontal dimensions at other parts are to be compared, in order to determine whether or not the individual presents those several proportions which are consistent with his age and development.

The model height of a growing lad at 18 years of age is 163 centimètres, *i.e.* equal to 64.17 inches; while the height of a man who has completed his

growth at 25 years of age is 175 centimètres, *i.e.* equal to 68.89 inches. Of course many exceptions occur, but then the correlation of other dimensions must be in accordance.

The following table represents in numbers of centimètres the relative augmentations of increase at the ages from the completed 18th year to the completed 24th year, arranged in the following columns :—

I. Age at the end of the year stated.

II. Length of the neck.[1]

III. Length of the head.

IV. Length of the sternum.

V. Distance between xiphoid cartilage and pubic symphysis. The navel ought to mark exactly the middle point of this line.

VI. The total length of the thigh and leg, measured from the horizontal level of the pubic symphysis vertically to the centre of the internal malleolus. The articulation of the knee ought to mark the division of this line into two equal parts ; and thus the thigh from the hip-joint to the knee ought to be equal to the length of the leg from the knee to the internal malleolus.

VII. The distance from the sole of the foot to the centre of malleolus.

(These complete the six fundamental dimensions to be first determined.)

VIII. Upper length of the body from the vertex of the head to the upper margin of the pubic symphysis.

[1] See the paragraphs above, and numbered 1-6, for the definite points to measure from.

IX. Lower length of the body from the upper margin of the pubic symphysis to the sole of the foot.

X. Total length from the vertex to the sole.

(The upper extremities being extended horizontally, the following measurements are then to be made.)

XI. Length of the clavicle. It ought to be equal in length to the open hand.

XII. Length of the forearm, from the middle of the elbow-joint to the carpal joint.

XIII. Length of the upper arm.

XIV. Distance of the head of the humerus from the middle line of the body.

XV. Half the length of the body. The distance between the tip of the middle finger of the one side to that of the other (the arms being extended horizontally) ought to be exactly equal to the length of the whole body.

XVI. The half-breadth of the shoulders. It ought to be equal to the half-breadth of the hips, and to $\frac{1}{10}$ of the length of the body.

XVII. The transverse diameter of the head.

XVIII. Antero-posterior diameter of the head.

XIX. Circumference of head (above the superciliary ridges).

XX. Girth of the chest immediately above both nipples.

XXI. Diameter of thorax. It ought to be equal to the diameter of pelvis.

TABLE XXVIII.—Relative Increase of Different Dimensions in the Growth of Man from the Ages of 18 to 25 Years (Francis Liharzik, M.D.)

(Unit of Measure = One Centimètre.)

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.
Age to the completion of the year.	Length of the			Distance between xiphoid cartilage and pubic symphysis. The navel marks the middle distance.	Total length of thigh and leg.	Distance from sole of foot to centre of inner malleolus.	Distance from vertex of head to upper margin of pubic symphysis.	Distance from upper margin of pubic symphysis to sole of foot.	Total length from vertex of head to sole of foot.	Upper extremities being extended horizontally, length					Half the breadth of the shoulders.	Transverse diameter of head.	Antero-posterior diameter of head.	Circumference of head.	Girth of chest.	Diameter of thorax.
										Of clavicle.	Of forearm.	Of upper arm.	From middle line of body to head of humerus.	Half-length of body to be noted here.						
18	7	23	21	12 +12	82	6	75	88	163	$19\frac{11}{12}$	$22\frac{3}{4}\frac{4}{8}$	$29\frac{1}{2}\frac{6}{8}$	10	$81\frac{5}{8}$	$16\frac{1}{2}\frac{8}{8}$	$16\frac{5}{8}$	19	54	78	21
19	$7\frac{1}{2}$	$23\frac{2}{8}$	$21\frac{2}{8}$	$12\frac{2}{8}+12\frac{2}{8}$	$82\frac{6}{8}$	$6\frac{1}{2}$	76	89	165	$19\frac{1}{2}$	$22\frac{1}{2}\frac{0}{8}$	$29\frac{1}{2}$	$10\frac{1}{8}$	$82\frac{1}{8}$	$16\frac{3}{8}\frac{3}{8}$	$16\frac{1}{2}$	$19\frac{1}{2}$	$54\frac{1}{2}$	$81\frac{6}{8}$	$21\frac{1}{2}$
20	$7\frac{1}{2}$	$23\frac{1}{2}$	$21\frac{1}{2}$	$12\frac{4}{8}+12\frac{4}{8}$	83	7	77	90	167	20	$23\frac{2}{8}$	$30\frac{1}{2}$	$10\frac{1}{2}$	$83\frac{1}{8}$	$16\frac{4}{8}\frac{4}{8}$	17	20	55	85	22
21	8	$23\frac{3}{8}$	$21\frac{3}{8}$	$12\frac{6}{8}+12\frac{6}{8}$	$83\frac{1}{8}$	$7\frac{1}{2}$	78	91	169	$20\frac{1}{8}$	$23\frac{5}{8}\frac{0}{8}$	$30\frac{5}{8}$	$10\frac{3}{8}$	$84\frac{1}{8}$	$16\frac{5}{8}\frac{5}{8}$	$17\frac{1}{8}$	$20\frac{1}{8}$	$55\frac{1}{8}$	$88\frac{1}{8}$	$22\frac{1}{8}$
22	$8\frac{1}{8}$	$23\frac{4}{8}$	$21\frac{4}{8}$	$12\frac{8}{8}+12\frac{8}{8}$	84	$7\frac{5}{8}$	79	92	171	$20\frac{3}{8}$	$23\frac{7}{8}\frac{0}{8}$	$30\frac{7}{8}$	$10\frac{5}{8}$	$85\frac{1}{8}$	$17\frac{1}{8}\frac{1}{8}$	$17\frac{1}{8}$	$20\frac{3}{8}$	56	92	23
23	$8\frac{2}{8}$	$23\frac{5}{8}$	$21\frac{5}{8}$	$12\frac{10}{8}+12\frac{10}{8}$	$84\frac{5}{8}$	$8\frac{1}{8}$	80	93	173	$20\frac{5}{8}$	$24\frac{1}{8}\frac{2}{8}$	$31\frac{1}{8}$	$10\frac{5}{8}$	$86\frac{1}{8}$	$17\frac{2}{8}\frac{2}{8}$	$17\frac{3}{8}$	$20\frac{5}{8}$	$56\frac{5}{8}$	$95\frac{1}{8}$	$23\frac{1}{8}$
24	9	24	22	13 +13	85	9	81	94	175	21	$24\frac{1}{8}$	$31\frac{1}{8}$	$10\frac{1}{2}$	$87\frac{1}{8}$	$17\frac{3}{8}\frac{3}{8}$	$17\frac{1}{8}$	21	57	99	24

All the measurements must be taken while the naked body of the recruit is stretched at rest on a horizontal solid plane surface (not a bed), and measurement by centimètres is by far the most useful for comparison. No recruit or soldier ought to be measured in the erect attitude. Men are able to raise or lower their stature to an appreciable extent when erect, but not in the horizontal position (see p. 79).

There ought also to be the means within reach of giving a recruit or a soldier a warm bath, with proper supervision that the bath is efficiently performed. Not only is a warm bath necessary for the sake of cleanliness, but it may be necessary to do away with any enamel or artificial colour applied to the skin of the face to subdue the evidences of age.

The greater the formality and exhaustiveness with which the details of such physical indications are carried out upon the fixed principles already described, the more is the judgment or conclusion arrived at removed from being a mere guess, and the less likely will the drunkards or bad characters discharged the service present themselves for the ordeal without detection from some one or other point of investigation. The gait alone in some instances may be sufficient to indicate a drilled soldier.

If pains be taken to ascertain that the relative dimensions of the body (as set forth in the Table XXVIII.) are in accordance with the height; that the growth and form of the face and of the jaws are

in accordance with development; that the condition of the jaws conforms to the development of the third molars above and below; that all the teeth give the usual indications *in each class* of attrition on the summits of their crowns from use; that the external signs of puberty and the size of the hairs of the shaven beard are in accordance, as well as the gait and the tractile muscular force of the individual; then I believe that such a formal and exhaustive method of investigation will embrace a combination of physical indications sufficient to guide medical officers in forming an opinion as to the age of a full-grown man seeking to enlist. Those who will take the necessary trouble to make the subject a careful study will come to a reasonably sound conclusion as distinguished from a mere guess, and no doubt some medical officers will be found more apt than others in acquiring the requisite practical experience in the methods of examination.

Systematic training and constant practical experience in the details of these methods of examination are necessary. A recruit should look his age and not older; and much judgment is required to rightly estimate the bodily appearance at various ages. This is only to be attained by practice, experience, and cultivated observation; and in the vocation of the military medical officer it is a valuable faculty to acquire and keep up.

It only now remains to notice the physical signs of the last epoch of age; the recognition of which is

perhaps the most important for the public service—namely, the indications of age from 26 or 27 to 30 years.

The characteristic elongation of the face and jaws is complete, and the arch-curve of the jaw semi-elliptical.

The features and expression of the face have become fully unfolded, so as to exhibit all those modifications of character seen in the countenances of mature men; for the habits and occupations of life imprint upon the countenance and the mature frame certain general appearances with which one soon becomes experienced so as to recognise them.

The skin, particularly of the face, and the hair of the head and beard are fully developed, and the hair is in its greatest perfection of growth. The skin is dense and thick, and no longer smooth on the face. Its *rete mucosum* becomes dusky or dark, and the hairs of the head may begin to show single white or gray ones intermingled, especially in the temporal regions.

The attrition from use of the crowns of the several sets of teeth is more obviously marked. The wisdom teeth, if they exist and are not decayed, ought to be fully exposed and in position. If they have existed, sufficient indications will remain in the breadth and deepness of the alveolar processes above and below.

The external signs of puberty are fully expressed, and the scrotum has become pendulous.

The dimensions of the several parts of the body and the tractile force of the muscles are at their *maximum.*

The muscles of voluntary motion, and especially those of the extremities, are prominently increased in development, and are at their *maximum* bulk. The chest and parietes of the large cavities are also fully developed.

The height and weight of the man are at the best for active work, and their correlation as an indication of age has been fully shown in the tables already given.

After 30 years the physical indications of age become so obvious as to require no great experience to recognise them.

The details of the several points mentioned will require to be taken with very great care and accuracy. They ought to be so fully recorded in every particular that the records of any individual should be able to identify him, inasmuch as no two persons are exactly alike in their physical indications of age and defects. I need not add that the aim and objects of the work are so important as to justify every care and attention being bestowed upon it, if satisfactory and trustworthy results are to be obtained.[1]

These varied modes of viewing the subject confirm the conclusion that there ought to be fixed average standards of *height, weight,* and *chest-girth* in

[1] See Appendix to *Army Medical Department Report* for 1867.

relation to all ages as a basis for the selection of lads and men.

Looking therefore to the facts set forth in the previous pages regarding (1) age and the youthfulness of recruits; (2) height; (3) weight; (4) chest-girth, chest-mobility, and "pulmonary play;" (5) the development and growth of the bones of the skeleton; (6) the development and gradual growth of the heart, lungs, liver, spleen, and kidneys, as recorded by the most eminent and painstaking anatomists; (7) the vital capacity of the chest as determined by experiments; (8) the correlation of the growth of muscle with bone; (9) the minute structure of bone in accordance with mechanical principles, and as influenced by its imperfect growth; (10) the progressive increase of muscular force with ages from 20 to 25; (11) the development of the teeth and progressive growth of the jaw-bones,—I think sufficiently cogent physiological reasons exist for the conclusion that—*first, the selection*, and *second, the physical training* of recruits, demand great circumspection and care.

The selection of recruits to be judicious implies a regard to the due concurrence of age, height, and development as the basis of selection; and their future treatment in training must be regulated accordingly.

We have seen that there are limits to the rate of growth affixed to the constitution of each individual, and although men may vary as to *height* and *weight*

within certain physiological limits, the age being the same, yet the *height* of a recruit should never be more than his age justifies. And if *a period of probation for training* is duly regulated and fully recognises physiological principles as its basis—principles which cannot, indeed, be disregarded with impunity —then the age at which the training commences is not of much moment, provided the nature of the training as to amount of exertion is suited to the years of the recruit. But for the economy of the training system, the more normal the concurrence of *age, height, weight, chest-girth, and mobility as to its expansion and capacity, and general development*, that can be obtained, the better and more economical will be the result.

During the past 25 years I have regularly brought these topics more or less fully to the notice of the surgeons on probation at Netley, because the condition and the growth of the recruit and the young soldier naturally challenge our attention at the outset ; and as an example of how we must take a broad and strictly physiological view of pathology in order to "appreciate the causes and the nature of disease in military life."

The improper selection of "growing lads ;" the injudicious exercises and over-exertion of military drills, with an insufficient dietary, tend in the first instance to encumber the military hospitals, and if the system does not lead to the premature death of the young soldier, he is sooner or later thrown out

upon the civil population with one or more of his vital organs damaged for the remainder of his life.

The service of such young soldiers, who are no sooner out of the hospital than they are in again, can only be regarded as merely *nominal* service ; and the "strength" of an army composed of such material can never constitute a very formidable phalanx.

A period of probation for training is absolutely necessary in order to observe whether or not there are any circumstances in the everyday life of the man indicative of any "constitutional state," under which, for example, "phthisis," or any other affection of a constitutional kind, is likely to develop itself. Time is required to make such observations, and no better time can be set aside for this purpose than a period of probation for the recruit. Surely it were much better that this be done with all as a rule before the ranks of the army are filled up by them indiscriminately, than that these ranks be filled up by those who, if not actually ill, are more or less constantly in hospital.

Vegetius tells us that the conditions under which the ranks of the Roman army were recruited involved a *lengthened period of probation* for recruits. Before a Roman conscript was finally approved, he underwent a probation of four months, for the purpose of ascertaining whether he was in all respects fit for military service. When at the end of that period it was satisfactorily proved that he had sufficient activity and strength to enable him to surmount

the hardships of a soldier's life, and if at the same time it appeared that he possessed the requisite mental capacity, and a due degree of courage, the military mark was indelibly imprinted on his hand. This extreme care in the selection of its material was no doubt one of the causes of the early invincibility of the Roman legions.

APPENDIX I

Revised Schedule of the Age, Height, Weight, and Chest-Measurement of Recruits for the Regular Army and the Militia. (Appendix to General Order 9, 1886.)

1. Under Scale A medical officers (including civilian medical practitioners authorised to examine recruits) will certify as to the actual fitness of a recruit for the Regular Army; but it will rest with the recruiting officer or the recruiter to see, from the description given by the medical officer on the second page of the attestation, that the recruit is of the standard of age, height, and chest-measurement, laid down in Scale B, for the arm of the Service for which he wishes to enlist.

2. In the event of a recruit for the Regular Army not selecting any particular corps, he may be enlisted for general service, and will be appointed by the approving field officer to any corps for which recruiting is open, and for which he is eligible.

3. Medical officers and also recruiting officers and recruiters will be guided by Scale C in the examination of recruits for the Militia.

SCALE A.

4. *The following scale, showing the limits of age, height, chest-measurement, and weight, at which recruits offering for the Regular Army may be taken, is laid down for the guidance of medical officers in passing men as fit for the Service:—*

Age . . .	18 to 25 years (with the exceptions specified in Scale B).
Height . . .	5 feet 4 inches and upwards.
Chest-measurement	33 inches and upwards.
Weight . . .	115 lbs. and upwards.

In the event of the medical officer considering that a recruit is not physically equivalent to the age of 18 years he will at once reject him.

Eligible recruits, under 20 years of age, between 5 feet 3 inches and 5 feet 4 inches in height, who are in every other respect up to the above standards, may, if the medical officer considers they are likely to develop into efficient soldiers, be recommended by him to be specially enlisted for the *Infantry of the Line.*

SCALE B.

5. *The following scale, showing the age, height, chest-measurement, and other qualifications of recruits for the several arms of the Service* (*Regular Army*), *is laid down for the guidance of recruiting officers and recruiters :—*

AGE.

Limits of age for all arms of the Service (with the exceptions specified below)		18 to 25 years.
Corps of Ordnance Artificers		21 to 30 years.
Medical Staff Corps		18 to 28 years.
Post-Office Corps		19 to 30 years.
Royal Engineers	Military Mechanists	21 to 30 years.
	Post-Office Telegraphists. For immediate transfer to the Army Reserve . .	19 to 30 years.

Men who have been discharged from the Army, Royal Marines, Royal Navy, or Royal Irish Constabulary, may be permitted to re-enlist in the Army up to the age of 28 years, provided they are not ineligible in other respects.

Height and Chest-Measurement.

Corps.			Height.	Chest-Measurement.
Cavalry	Heavy	4th Dragoon Guards 5th ,, 1st Dragoons 2d ,,	5 ft. 8 in. to 5 ft. 11 in.	Under 5 ft. 10 in. in height, 34 in. 5 ft. 10 in. and over, 35 in.
	Medium	1st Dragoon Guards 2d ,, 3d ,, 6th ,, 7th ,, 5th Lancers 6th Dragoons 9th Lancers 12th ,, 16th ,, 17th ,,	Lancers, 5 ft. 7 in. to 5 ft. 9 in. Other Regiments, 5 ft. 6 in. to 5 ft. 9 in.	
	Light	3d Hussars 4th ,, 7th ,, 8th ,, 10th ,, 11th ,, 13th ,, 14th ,, 15th ,, 18th ,, 19th ,, 20th ,, 21st ,,	5 ft. 6 in. to 5 ft. 8 in.	
Royal Artillery	Gunners		5 ft. 6 in. and upwards	Under 5 ft. 10 in. in height, 34 in. 5 ft. 10 in. and over, 35 in.
	Drivers		5 ft. 4 in. to 5 ft. 6 in.	34 in.
	Artificers—			
	Smiths		5 ft. 4 in. and upwards	33 in.
	Wheelwrights			
	Harness Makers			
	Tailors		5 ft. 4 in. and upwards	
Royal Engineers	Sappers	Other than shoemakers and tailors	5 ft. 6 in. and upwards	Under 5 ft. 10 in. in height, 34 in. 5 ft. 10 in. and over, 35 in.
		Shoemakers & tailors	5 ft. 5 in. and upwards	33 in.
	Drivers		5 ft. 4 in. to 5 ft. 6 in.	34 in.
	Post-Office Telegraphists, enlisted for immediate transfer to the Army Reserve		5 ft. 5 in. and upwards	Under 5 ft. 6 in. in height, 33 in. 5 ft. 6 in. and under 5 ft. 8 in., 34 in. 5 ft. 8 in. and over, 35 in.

HEIGHT AND CHEST-MEASUREMENT—*Continued.*

Corps.		Height.	Chest-Measurement.
Infantry	Foot Guards	5 ft. 8 in. and upwards	Under 5 ft. 10 in. in height, 34 in. 5 ft. 10 in. and over, 35 in.
	Infantry of the Line	5 ft. 4 in. and upwards	Under 5 ft. 6 in. in height, 33 in. 5 ft. 6 in. and under 5 ft. 10 in., 34 in. 5 ft. 10 in. and over, 35 in.
	Tailors, when ordered to be enlisted, may be taken 2 inches below the ordinary standard of height, and 2 inches under the chest-measurement.		
Commissariat and Transport Corps	Drivers	5 ft. 4 in. to 5 ft. 6 in.	The same as for the Infantry of the Line.
	Other recruits	5 ft. 4 in. and upwards	
	Ordnance Store Corps	5 ft. 5 in. and upwards	
	Corps of Ordnance Artificers	5 ft. 4 in. and upwards	
	Medical Staff Corps	5 ft. 4 in. and upwards	
	Post-Office Corps	5 ft. 4 in. and upwards	
	West India Regiments	5 ft. 4 in. and upwards	33 in. and upwards.

6. The under-mentioned classes of recruits may, if passed by the medical officer as likely to become efficient soldiers, be specially enlisted for the *Cavalry and Infantry of the Line*, viz.—

(*a*) Recruits for the Cavalry of the Line, under 20 years of age, who are within 1 inch of the chest-measurement prescribed.

(*b*) Recruits for the Infantry of the Line, under 20 years of age, who are under 5 feet 4 inches, but not less than 5 feet 3 inches in height, and also those who are within 1 inch of the chest-measurement prescribed, provided they are not less than 33 inches chest-measurement.

Approving Field Officers will be held responsible that only specially good men are finally approved under this paragraph. Their retention will also rest with the approving Field Officer, who, if he does not consider them fit for the Service, will carry out their discharge at once, under paragraph 227 (*a*), Section XIX., of the *Queen's Regulations*.

This paragraph will be quoted on the second page of the Attestation, and in the Weekly Return of Recruits finally approved (Army Form B 211), as the authority for special enlistment in each case.

7. In the event of an approving Field Officer thinking it desirable to retain a specially good man who does not come up to the standard prescribed in this General Order for the corps which he desires to join, special authority may be applied for to the Inspector-General of Recruiting.

SCALE C.

8. *The following scale, showing the qualifications as to age, height, and chest-measurement of recruits for the Militia, is laid down for the guidance of examining Medical Officers and of Recruiting Officers and Recruiters :—*

ARTILLERY MILITIA.

	Age.	Height.	Chest-Measurement.
Men . .	18 to 35 years . .	5 ft. 6 in. and upwards	33 in. and upwards.
Growing lads	Between 17 to 18 years	5 ft. 5 in. and upwards	(*See* below).

ENGINEER MILITIA.

	Age.	Height.	Chest-Measurement.
Men . .	18 to 35 years . .	5 ft. 5 in. and upwards	33 in. and upwards.
Good tradesmen and boatmen .		5 ft. 4 in. and upwards	
Growing lads	Between 17 and 18 years	5 ft. 3 in. and upwards	(*See* below).

INFANTRY MILITIA.

	Age.	Height.	Chest-Measurement.
Men . .	18 to 35 years . .	5 ft. 4 in. and upwards	32 in. and upwards.
Growing lads	Between 17 and 18 years	5 ft. 3 in. and upwards	(*See* below).

The chest-measurement of growing lads will be left to the discretion and judgment of the examining medical officer.

9. Men who do not answer the foregoing requirements, but who are desirable recruits in other respects, may, if considered by the Medical Officer likely to develop into efficient Militiamen, be specially enlisted under the authority of the approving Field Officer. When the recruit is not to be drilled on enlistment, the authority for the special enlistment in these cases may be given by the Recruiting Officer, and the enlistment may be carried out subject to the final medical examination and final approval by the approving Field Officer.

Men who, with not less than three years' service, have been discharged from the Army, Army Reserve, or Royal Marines with good characters, but without pension, will be enlisted up to the age of 45 years.

APPENDIX II

RETURN showing the Minimum Age, Height, Chest-Measurement, etc., of Infantry Recruits with different European Armies. (Appendix F to *Report* for 1881, dated 1882.)

	Age of Enlistment.	Minimum Height.	Minimum Chest-Measurement.	Minimum Weight.	Remarks.
		ft. in.	in.	lbs.*	
England * .	The physical equivalent of 18	5 4	34	115	..
France .	20	5 0½	30.867	No instructions	Men below the standard who are likely to improve may be put back for a year.
Austria .	20†	5 1⅛	30.06	,,	Men below standard put back to next year or more.
Germany	20	5 1$\frac{5}{16}$	Chest is considered, but there is no fixed limit.	,,	The margin afforded by conscription admits of men of doubtful physique being rejected or put back for a year.
Russia .	21	5 0¼	No rules laid down.	,,	Men may be put back for one year or even for two years in order to grow and fill out.
Italy . .	20†	5 1.45	31.5‡	,,	..

* Appendix I.

† The year in which he becomes 20. ‡ For active service.

APPENDIX III

Extracts from the Queen's Regulations and Orders for the Army, 1885, relating to Recruits.

Sec. XIX. 27.—Discharged men, provided not otherwise ineligible, may be re-enlisted up to age of 28.

29.—Terms of service as to long or short defined. *Long service*—12 years' army service. *Short service*—7 years' army service, and 5 years' reserve. Also convertible into 8 years' army service and 4 years' reserve if period of army service expires while the man is serving abroad.

30.—For Foot Guards. *Long service*—12 years army. *Short service*—3 years army, and 9 years reserve.

32.—All enlistments will be for short service, with some exceptions (—given), these include boys.

33.—Authority for special enlistment is required when—

(*a*) Recruits are not conformable to established regulations as to age and standard of height, or chest-measurement, but desirable in other respects. To be made by approving officer to Adjutant-General on a specified form (B. 203).

41.—". . . The medical officer is responsible for the measurements of recruits."

44.—Instruction for medical examination of recruits as in Army Medical Regulations.

45.—All military medical officers and also medical officers of militia and yeomanry when embodied or out for training are empowered to carry out the final examination of recruits, but civilian medical practitioner may be appointed to conduct primary medical examination.

257.—Service under Act 1847, reckoned for purpose of discharge from date of attestation, provided he was at that time of or above age of 18, if not, then from day on which he shall have completed the age of 18 years.

Date of commencement of service in subsequent acts is from date of attestation.

APPENDIX IV

Extracts from Regulations for the Medical Department of Her Majesty's Army, 1885, relative to Recruits.

972.—The height, weight, and chest-measurement of a recruit should accord with each other, and with his age—agreeably to the standards laid down from time to time in General Orders.

974.—The recruit being wholly undressed, he is to be measured under the standard. He is weighed, and weight recorded in lbs. His chest-measurement is taken. If he satisfies requirements in these respects, and appears otherwise eligible, the general examination will be proceeded with, from which an estimate is formed of his general physique, of his age, and whether he presents the appearance of having served before or not.

984.—The following are the instructions for determining the chest-measurements of recruits :—

"(*a*) The measuring tape will be passed round the chest, so that its posterior upper edge will be immediately below, and touch the shoulder-blades; while in front its anterior lower edge touches the upper part of the nipple, the arms meanwhile hanging loosely; the tape should not be drawn so tight as to compress the surface."

"(*b*) The tape having been thus applied, the recruit will be made to count slowly from 1 to 10, and the minimum measurement shown by the tape, while so counting, is to be considered the correct chest-measurement.

Determination of Age by Physical Development.

985.—Should a recruit on presenting himself for enlistment bring no satisfactory proof of his age, the medical officer who examines him will, by comparing the height with the weight, general development and appearance, decide his apparent age, which will be entered on the second page of the attestation, and be accepted in all future official documents relating to him.

990.—The approving medical officer as defined (in Army Medical Regulations) is responsible for the measurement of recruits as regards standard of height, weight, and chest-girth, as well as for their apparent age being in accordance with the schedules given in general orders from time to time.

991.—The medical officer will enter on the original attestation the following particulars in his own handwriting:—Apparent age, height (weight), chest-girth, complexion, colour of hair and eyes, and any distinctive marks; writing "none" where there are none; and under this head is to be given (993) any evidence or opinion of medical officer that the recruit had previously secured.

995.—Approving medical officers will conduct the examination of recruits, and record the facts arrived at with due care, and to the best of their judgment; but they will not be held responsible for the ultimate rejection of recruits on grounds involving a decision contrary to the opinions they may have expressed.

1000.—Medical Boards reporting on recruits will invariably record an opinion on the specific disabilities alleged as well as on general fitness for service; when the objection is to height or chest-measurement they will also record their own measurements in inches and parts of an inch.

SEC. XIX. 281.—Boys (of good character) may be enlisted between 14 and 16 years of age for purpose of being trained as trumpeters, drummers, buglers, musicians, or tailors.

291.—Boys of 17 and 18 on attaining age of 18 will cease to be included in roll of boys, and will be counted as privates, if physically fit, otherwise to be reported upon as physically unfit.

301.—No pensioner eligible for re-enlistment who is over 45 years of age.

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